E-R DIAGRAM SYLLABUS

- Introduction and basics ER diagram
- Entity, Entity set
- Attributes and types
- Relationship definitions, name, degree, cardinalities
- Strong and weak entity set
- Conversion of ER diagram into relational model
- ER diagram traps

E-R DIAGRAM/MODEL

- Introduced in 1976 by Dr Peter Chen, a non-technical design method works on conceptual level based on the perception of the real world.
- It consists of collections of basic objects, called entities and of relationships among these entities and attributes which defines their properties.
- E-R data model was developed to facilitate database design by allowing specification of an enterprise schema that represents ***the overall logical structure of a database***.
- E-R model is very useful in mapping the meanings and interactions of real-world enterprises onto a conceptual schema.
- It is free from ambiguities and provides a standard and logical way of visualizing the data.
- As basically it is a diagrammatical representation easy to understand even by a non-technical user.

Q An Entity - relationship diagram is a tool to represent: **(NET-JUNE-2005)**

(A) Data model
(B) Process model
(C) Event model
(D) Customer model

Ans: a

E R MODEL BASIC

- **ENTITY-** An entity is a thing or an object in the real world that is distinguishable from other object based on the values of the attributes it possesses.
- An entity may be **concrete**, such as a person or a book, or it may be **abstract**, such as a course, a course offering, or a flight reservation.
  Types of Entity-
  - *Tangible - Entities which physically exist in real world. E.g. - Car, Pen, locker*
  - *Intangible - Entities which exist logically. E.g. – Account, video.*

Name	FName	City	Age	Salary
Smith	John	3	35	$280
Doe	Jane	1	28	$325
Brown	Scott	3	41	$265
Howard	Shemp	4	48	$359
Taylor	Tom	2	22	$250

- In ER diagram we cannot represent an entity, as entity is an instant not schema, and ER diagram is designed to understand schema
- In a relational model entity is represented by a row or a tuple or a record in a table.

ENTIY SET- Collection of same type of entities that share the same properties or attributes.

- In an ER diagram an entity set is represented by a rectangle
- In a relational model it is represented by a separate table

Name	FName	City	Age	Salary
Smith	John	3	35	$280
Doe	Jane	1	28	$325
Brown	Scott	3	41	$265
Howard	Shemp	4	48	$359
Taylor	Tom	2	22	$250

Q An entity instance is a single occurrence of an _____. **(NET-JULY-2010)**
(A) entity type
(B) relationship type
(C) entity and relationship type
(D) None of these
Ans: a

Q An entity has: (**NET-DEC-2008)**
(i) a set of properties
(ii) a set of properties and values for all the properties
(iii) a set of properties and the values for some set of properties may non-uniquely identify an entity
(iv) a set of properties and the values for some set of properties may uniquely identify an entity
Which of the above are valid?
(A) (i) only **(B)** (ii) only **(C)** (iii) only **(D)** (iv) only
Ans: d

Q The E-R model is expressed in terms of: **(NET-DEC-2004)**
(i) Entities
(ii) The relationship among entities
(iii) The attributes of the entities
Then
(A) (i) and (iii)
(B) (i), (ii) and (iii)
(C) (ii) and (iii)
(D) None of the above
Ans: b

ATTRIBUTES

- Attributes are the units defines and describe properties and characteristics of entities.
- Attributes are the descriptive properties possessed by each member of an entity set. for each attribute there is a set of permitted values called domain.
- In an ER diagram attributes are represented by ellipse or oval connected to rectangle.
- While in a relational model they are represented by independent column. e.g. Instructor (ID, name, salary, dept_name)

Name	FName	City	Age	Salary
Smith	John	3	35	$280
Doe	Jane	1	28	$325
Brown	Scott	3	41	$265
Howard	Shemp	4	48	$359
Taylor	Tom	2	22	$250

Q In a relational schema, each tuple is divided in fields called: **(NET-DEC-2005)**

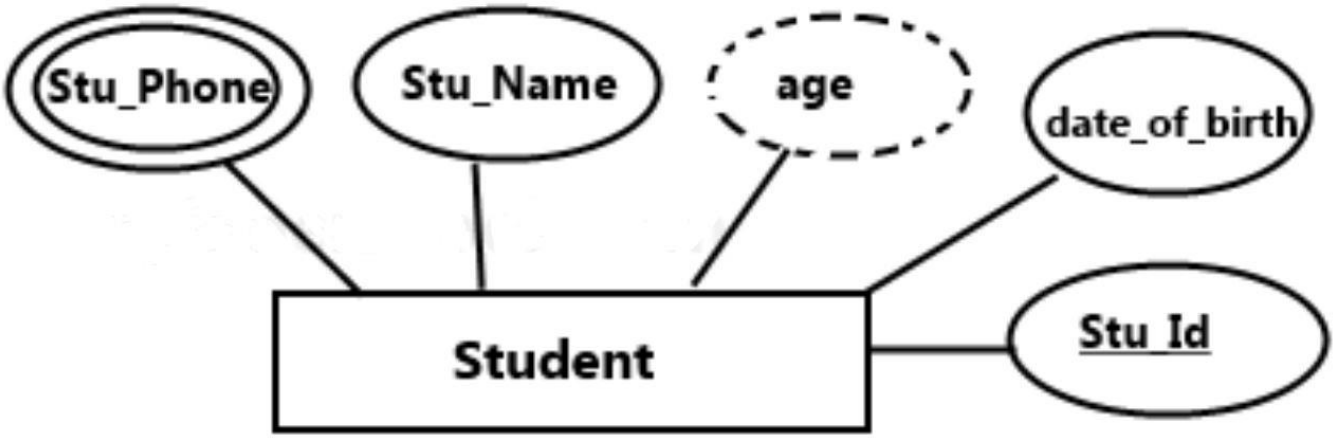
(A) Relations **(B)** Domains

(C) Queries **(D)** All the above

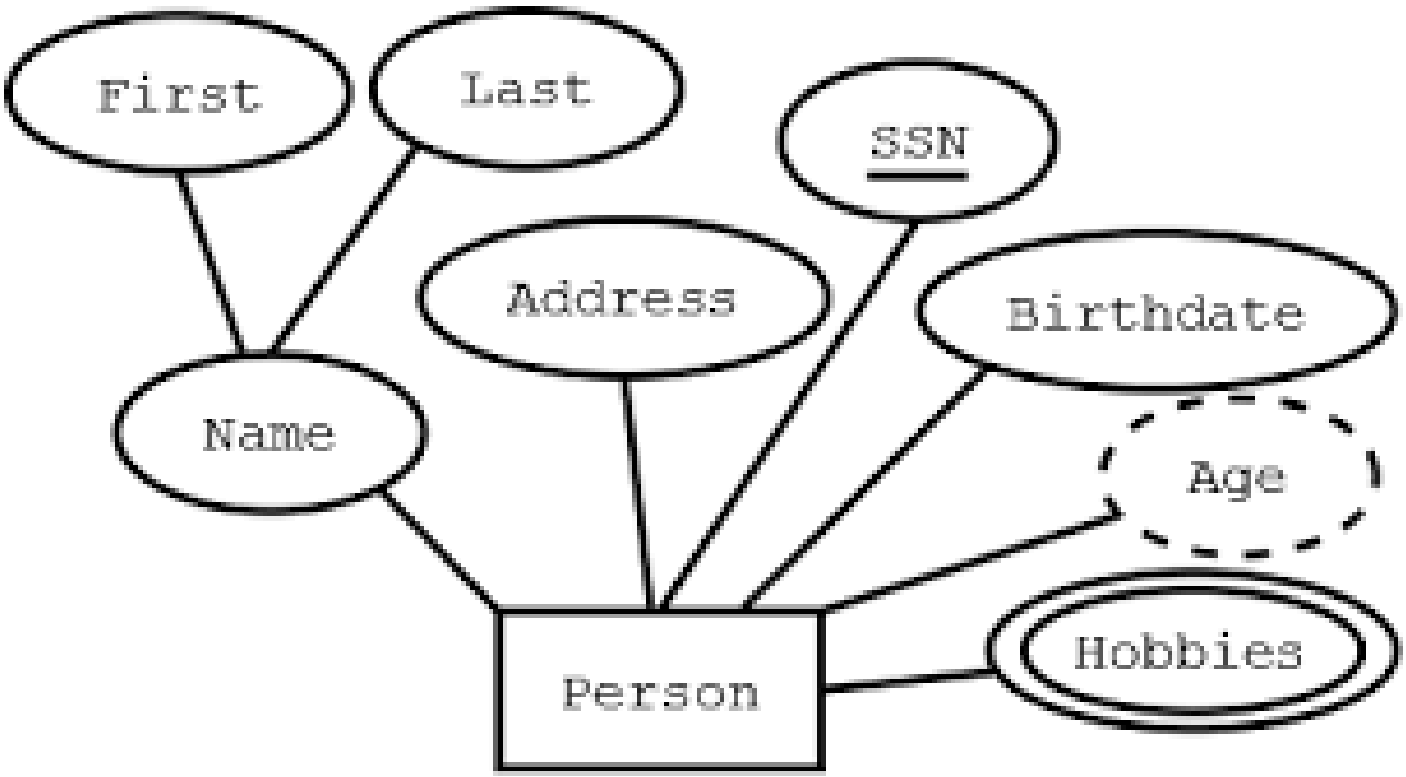
Ans: b

Types of Attributes

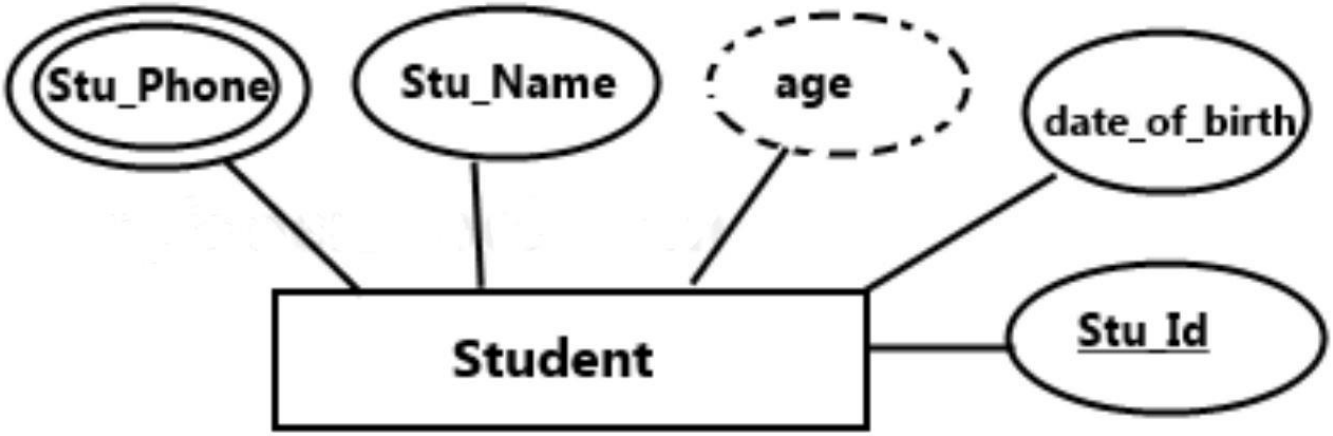
- **Single valued**- Attributes having single value at any instance of time for an entity. E.g. – Aadhar no, dob.
- **Multivalued** - Attributes which can have more than one value for an entity at same time. E.g. - Phone no, email, address.
    - A multivalued attribute is represented by a double ellipse in an ER diagram and by an independent table in a relational model.
- Separate table for each multivalued attribute, by taking mva and pk of main table as fk in new table



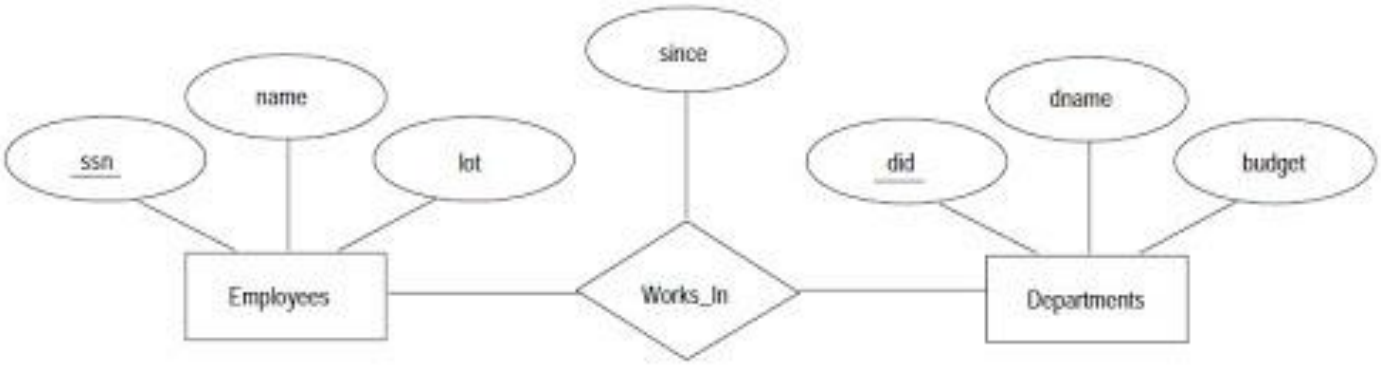
- **Simple** - Attributes which cannot be divided further into sub parts. E.g. Age
- **Composite** - Attributes which can be further divided into sub parts, as simple attributes. A composite attribute is represented by an ellipse connected to an ellipse and in a relational model by a separate column.



- **Stored** - Main attributes whose value is permanently stored in database. E.g. date_of_birth
- **Derived** -The value of these types of attributes can be derived from values of other Attributes. E.g. - Age attribute can be derived from date_of_birth and Date attribute.



- **Descriptive attribute** - Attribute of relationship is called descriptive attribute.
- An attribute takes a null value when an entity does not have a value for it. The null value may indicate “not applicable”— that is, that the value does not exist for the entity.



- Null can also designate that an attribute value is **unknown**. An unknown value may be either missing (the value does exist, but we do not have that information) or not known (we do not know whether or not the value actually exists).

Relationship / Association

- Is an association between two or more entities of same or different entity set.
- In ER diagram we cannot represent individual relationship as it is an instance or data.
- Note: - normally people use word relationship for relationship type so don't get confused.

Q The E-R model is expressed in term of **(NET-DEC-2009)**
I. Entities
II. The relationship among entities.
III. The attributes of the entities.
IV. Functional relationship.
(A) I, II **(B)** I, II, IV **(C)** II, II, IV **(D)** I, II, III
Ans: d

Q A schema describes: **(NET-DEC-2005)**
(A) data elements **(B)** records and files
(C) record relationship **(D)** all of the above
Ans: d

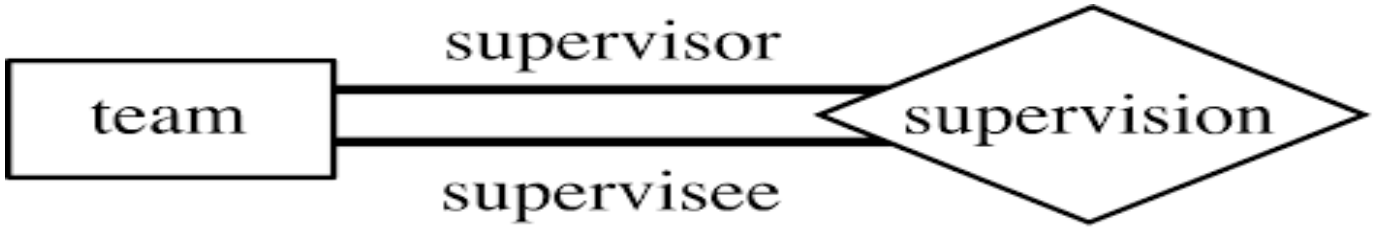
- In an ER diagram it is represented by a diamond, while in relational model sometimes through foreign key and other time by a separate table.

- Every relationship type has three components. Name, Degree, Structural constraints (cardinalities ratios, participation)

- **NAME**- every relation must have a unique name.

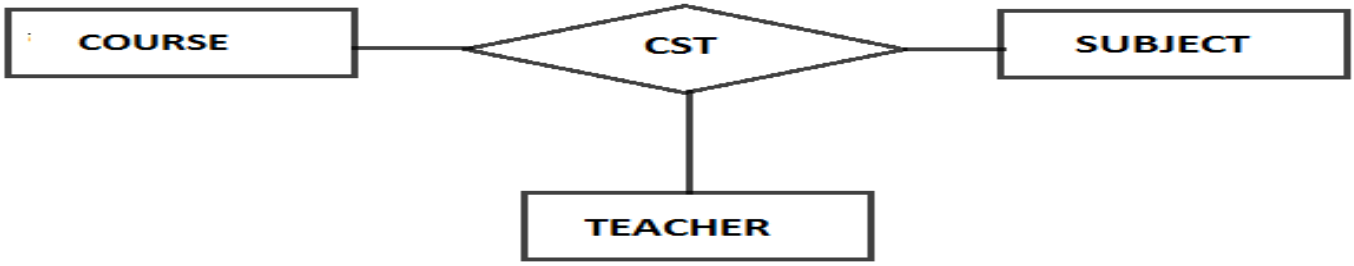
- **Degree of a relationship/relationship set**: - Means number of entities set(relations/tables) associated(participate) in the relationship set. Most of the relationship sets in a data base system are binary. Occasionally however relationship sets involve more than two entity sets. Logically, we can associate any number of entities set in a relationship called N-ary Relationship.

- **Unary Relationship** - One single entity set participate in a Relationship, means two entities of the same entity set are related to each other. These are also called as self - referential Relationship set. E.g.- A member in a team maybe supervisor of another member in team.

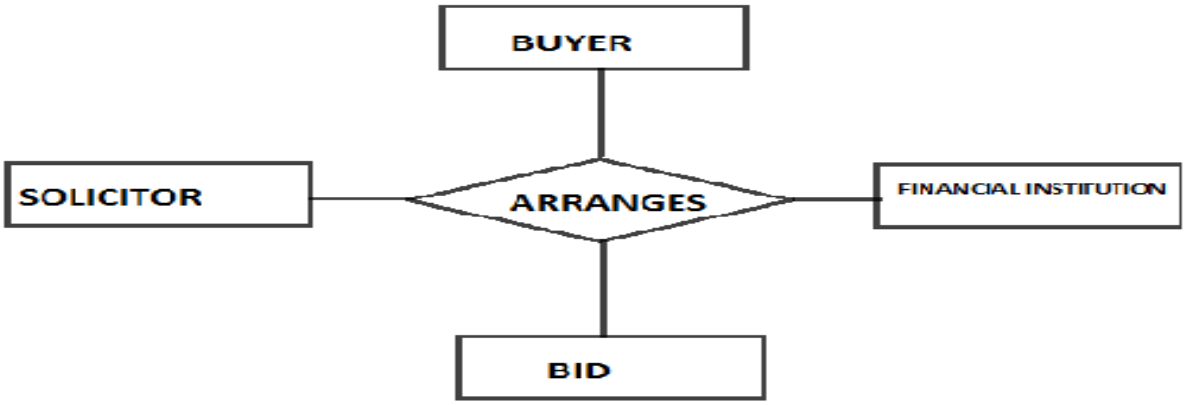


- **Binary Relationship** - Two entity sets participate in a Relationship. It is most common Relationship.

- **<u>Ternary Relationship</u>** - When three entities participate in a Relationship. E.g. The University might need to record which teachers taught which subjects in which courses.



- **<u>Quaternary Relationship</u>** - When four entities participate in a Relationship.



- **<u>N-ary relationship</u>** – where n number of entity set are associated
- But the most common relationships in ER models are ***Binary***.

- **Conversion of relationship having degree more than 2**
- Separate table is required take pk of every table and declare their combination as pk of new table.

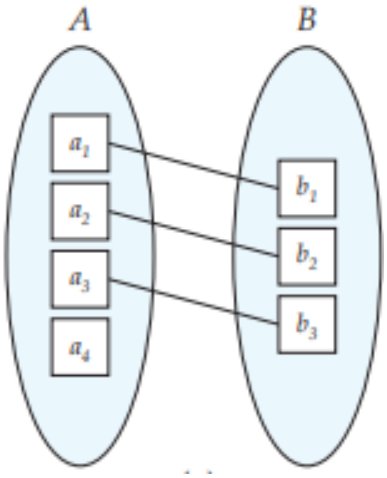
Structural constraints (Cardinalities Ratios, Participation)

- An E-R enterprise schema may define certain constraints to which the contents of a database must conform.

MAPPING CARDINALITIES / CARNINALITY RATIOS

- Express the number of entities to which another entity can be associated via a relationship set. Four possible categories are-
  - One to One (1:1) Relationship.
  - One to Many (1: M) Relationship.
  - Many to One (M: 1) Relationship.
  - Many to Many (M: N) Relationship.

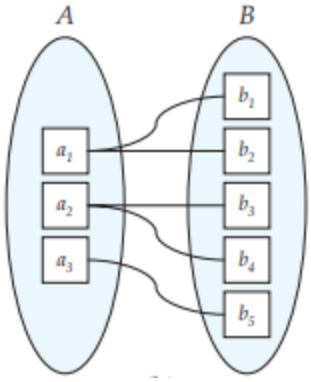
- **<u>One to One (1:1) Relationship-</u>** An entity in A is associated with at most one entity in B, and an entity in B is associated with at most one entity in A.



E.g.- The directed line from relationship set advisor to both entities set indicates that 'an instructor may advise at most one student, and a student may have at most one advisor'.

- **Conversion of 1-1 relationship(binary)**
- No separate table is required, take pk of one side as pk on other side, priority must be given to the side having total participation

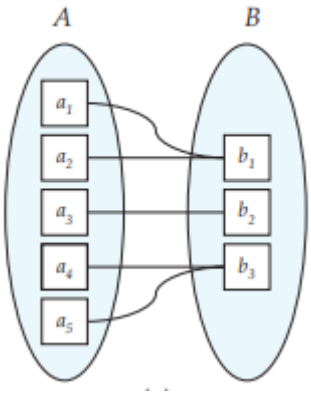
- **<u>One to Many (1: M) Relationship -</u>** An entity in A is associated with any number (zero or more) of entities in B. An entity in B, however, can be associated with at most one entity in A.



<u>E.g.-</u> This indicates that an instructor may advise many students, but a student may have at most one advisor.

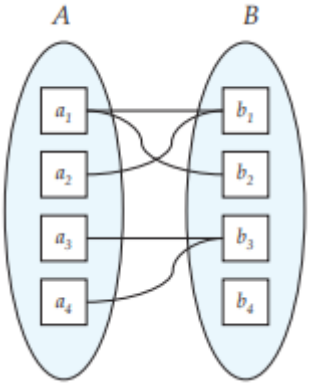
- **Conversion of 1-n or n-1 relationship (binary)**
- No separate table is required, modify n side by taking pk of 1 side a foreign key on n side

- **<u>Many to One (M: 1) Relationship-</u>** An entity in A is associated with at most one entity in B. An entity in B, however, can be associated with any number (zero or more) of entities in A.



E.g.- This indicates that student may have many instructors but an instructor can advise at most one student.

- ***Many to Many(M:N) Relationship***- An entity in A is associated with any number (zero or more) of entities in B, and an entity in B is associated with any number (zero or more) of entities in A.



E.g.- This indicates a student may have many advisors and an instructor may advise many students.

- In a Relationship there are two methods to represent about cardinalities either we write the numbers or an edge.

- **Conversion of n-n relationship (binary)**
- Separate table is required take pk of both table and declare their combination as a pk of new table

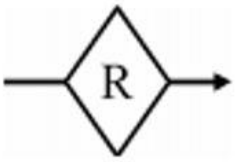
Q Match the following:

(a) 

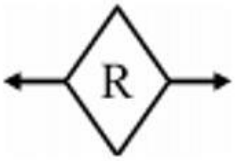
(i) One to one relationship

(b) 

(ii) Relationship

(c) 

(iii) Many to many relationship

(d) 

(iv) Many to one relationship

Codes:

	a	b	c	d
a	iii	iv	ii	i
b	iv	iii	ii	i
c	ii	iii	iv	i
d	iii	iv	i	ii

Participation constraints

- Participation constraint specifies whether the existence of an entity depends on its being related to another entity via the relationship type.
- These constraints specify the minimum and maximum number of relationship instances that each entity must/can participate in.
- ***Max cardinality*** – it defines the maximum no of times an entity occurrence participating in a relationship.
- ***Min cardinality*** **-** it defines the minimum no of times an entity occurrence participating in a relationship.
- **PARTICIPATION CONSTRAINTS-** it defines participations of entities of an entity type in a relationship.
    - **Partial participation**
    - **Total Participation**

PARTIAL PARTICIPATION **(min cardinality zero)** - In Partial participation only some entities of entity set participate in Relationship set, that is there exists at least one entity which do not participate in a relation.

TOTAL PARTICIPATION **(min cardinality at least one) -** In total participation every entity of an entity set participates in at least one relationship in Relationship set.

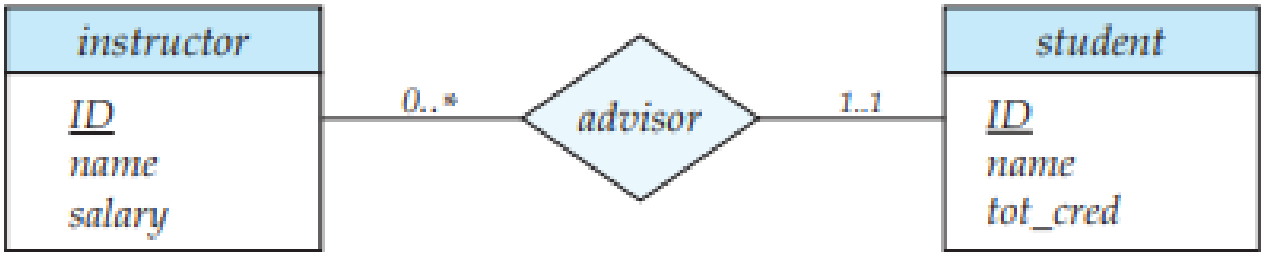
- Min max cardinalities can be represented either by single line double line or by ()min max() more information writing

Double lines indicate total participation of an entity in a relationship set.

Q What should be the condition for total participation of the entity in a relation?

a) Maximum cardinality should be one **b)** Minimum cardinality should be zero

c) Minimum cardinality should be one **d)** None of these



- A line may have an associated minimum and maximum cardinality, shown in the form l..h, where l is the minimum and h the maximum cardinality.
- The line between advisor and student has a cardinality constraint of 1..1, meaning the minimum and the maximum cardinality are both 1. That is, each student must have exactly one advisor.
- The limit 0..∗ on the line between advisor and instructor indicates that an instructor can have zero or more students. Thus, the relationship advisor is one-to-many from instructor to student, and further the participation of student in advisor is total, implying that a student must have an advisor.

Q In an Entity-Relationship (ER) model, suppose R is a many-to-one relationship from entity set E1 to entity set E2. Assume that E1 and E2 participate totally in R and that the cardinality of E1 is greater than the cardinality of E2. **(GATE-2018) (1 Marks)**
Which one of the following is true about R?
(a) Every entity in E1 is associated with exactly one entity in E2
(b) Some entity in E1 is associated with more than one entity in E2
(c) Every entity in E2 is associated with exactly one entity in E1.
(d) Every entity in E2 is associated with at most one entity in E1
Ans: a

Q An ER model of a database consists of entity types A and B. These are connected by a relationship R which does not have its own attribute. Under which one of the following conditions, can the relational table for R be merged with that of A? (GATE-2017) (1 Marks)
(a) Relationship R is one-to-many and the participation of A in R is total
(b) Relationship R is one-to-many and the participation of A in R is partial
(c) Relationship R is many-to-one and the participation of A in R is total
(d) Relationship R is one-to-many and the participation of A in R is partial
Ans: c

Q Consider an Entity-Relationship (ER) model in which entity sets E1 and E2 are connected by an m: n relationship R12, E1 and E3 are connected by a 1: n (1 on the side of E1 and n on the side of E3) relationship R13. E1 has two single-valued attributes a11 and a12 of which a11 is the key attribute. E2 has two single-valued attributes a21 and a22 is the key attribute. E3 has two single valued attributes a31 and a32 of which a31 is the key attribute. The relationships do not have any attributes. If a relational model is derived from the above

ER model, then the minimum number of relations that would be generated if all the relations are in 3NF is _____. **(GATE-2015) (2 Marks)**

a) 2 **b)** 3 **c)** 4 **d)** 5

Answer: 4

Q Let M and N be two entities in an E-R diagram with simple single value attributes. R1 and R2 are two relationship between M and N, where as
R1 is one-to-many and R2 is many-to-many.
The minimum number of tables required to represent M, N, R1 and R2 in the relational model are _____. **(NET-JAN-2017)**

(1) 4 **(2)** 6 **(3)** 7 **(4)** 3

Ans: 4

Q Given the basic ER and relational models, which of the following is INCORRECT? **(GATE-2012) (1 Marks)**

(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

Ans: c

Q Let E1 and E2 be two entities in an E/R diagram with simple single-valued attributes. R1 and R2 are two relationships between E1 and E2, where R1 is one-to-many and R2 is many-to-many. R1 and R2 do not have any attributes of their own. What is the minimum number of tables required to represent this situation in the relational model? **(GATE-2005) (2 Marks)**

a) 2 **b)** 3 **c)** 4 **d)** 5

Ans: b

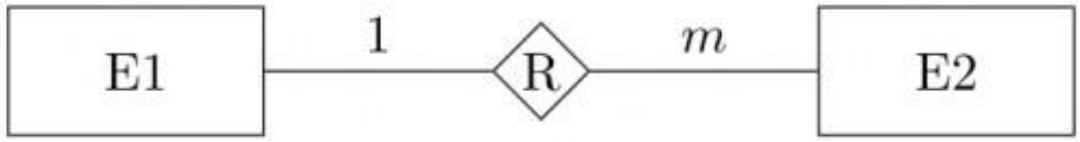
Q Consider the entities 'hotel room', and 'person' with a many to many relationship 'lodging' as shown below:

If we wish to store information about the rent payment to be made by person (s) occupying different hotel rooms, then this information should appear as an attribute of (GATE-2005) (1 Marks)

(A) Person **(B)** Hotel Room **(C)** Lodging **(D)** None of these

Ans: c

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 and 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 table satisfying the requirements of the third normal form (3NF) is designed from the above ERD. The number of tables in the database is (GATE-2004)(2 Marks)

(A) 2 **(B)** 3 **(C)** 5 **(D)** 4

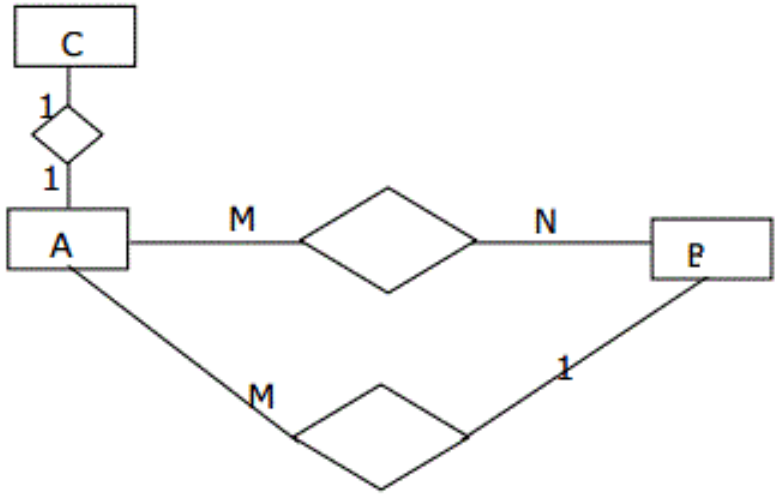
Ans: b

Q Let E1 and E2 be two entities in E-R diagram with simple single valued attributes. R1and R2 are two relationships between E1 and E2 where R1 is one - many and R2 is many - many. R1 and R2 do not have any attribute of their own. How many minimum numbers of tables are required to represent this situation in the Relational Model? **(NET-DEC-2015)**

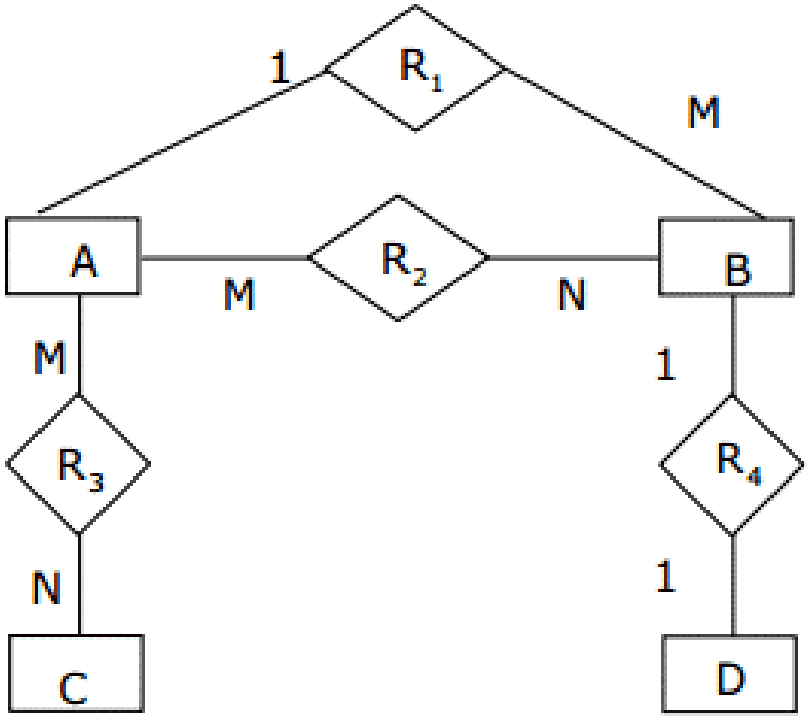
(1) 4 **(2)** 3 **(3)** 2 **(4)** 1

Ans. 2

Q The minimum number of tables required to convert the following ER diagram to relation model is _____

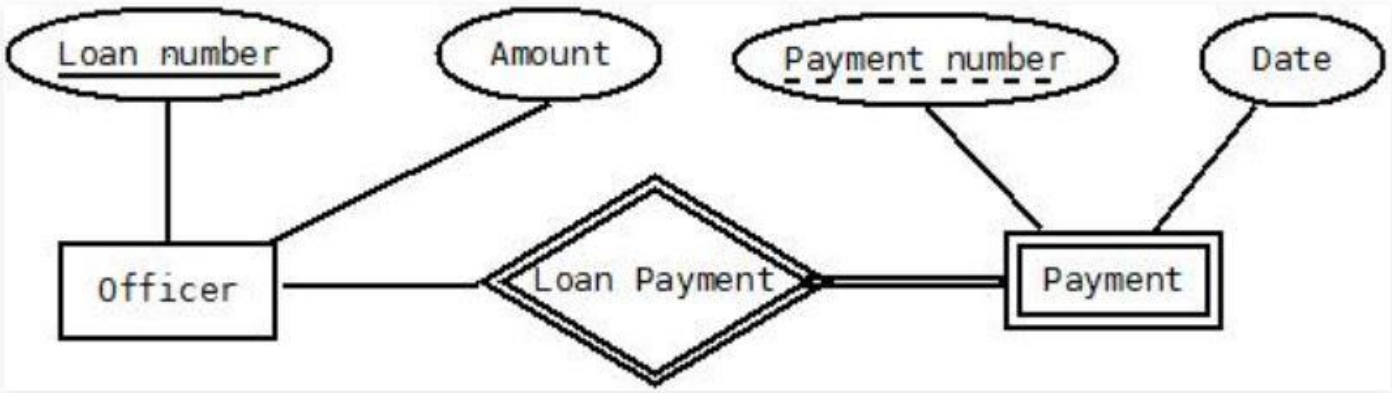


Q The minimum number of tables required to convert the following ER diagram to Relational model is _____



STRONG AND WEAK ENTITY SET

- A key for an entity is a set of attributes that suffice to distinguish entities from each other. The concepts of super key, candidate key, and primary key are applicable to entity sets just as they are applicable to relation schemas.
- An entity set is called strong entity set, if it has a primary key, all the tuples in the set are distinguishable by that key. Convert every strong entity set into an independent table
-
- An entity set that does not process sufficient attributes to form a primary key is called a weak entity set. It contains discriminator attributes (partial key) which contain partial information about the entity set, but it is not sufficient enough to identify each tuple uniquely. Represented by double rectangle
- The discriminator of a weak entity set is also called the ***partial key*** of the entity set.
    - The discriminator of a weak entity is underlined with a dashed, rather than a solid, line.



- For a weak entity set to be meaningful and converted into strong entity set, it must be associated with another entity set called the **identifying or owner entity set** i.e. weak entity set is said to be **existence dependent** on the identity set.
- The identifying entity set is said to own weak entity set that it identifies. the primary key of weak entity set will be the union of primary key and discriminator attributes.
- The relationship associating the weak entity set with the identifying entity set is called the **identifying relationship (double diamonds)**.
- The identifying relationship is many to one from the weak entity set to identifying entity set, and the participation of the weak entity set in relationship is always total.

- The identifying relationship set should not have any ***descriptive*** attributes, since any such attributes can instead be associated with the weak entity set.
- A weak entity set may participate as owner in an identifying relationship with another weak entity set.
    - Convert every weak entity set into a table

REASONS TO HAVE WEAK ENTITY SET

- Weak entities reflect the logical structure of an entity being dependent on another.
- Weak entity can be deleted automatically when their strong entity is deleted.
- Without weak entity set it will lead to duplication and consequent possible inconsistencies.

Q For a weak entity set to be meaningful, it must be associated with another entity set in combination with some of their attribute values, is called as: **(NET-DEC-2015)**

(1) Neighbor Set
(2) Strong Entity Set
(3) Owner Entity Set
(4) Weak Set

Ans. 3

Q Which of the following statements is FALSE about weak entity set? **(NET-DEC-2015)**

a) Weak entities can be deleted automatically when their strong entity is deleted.

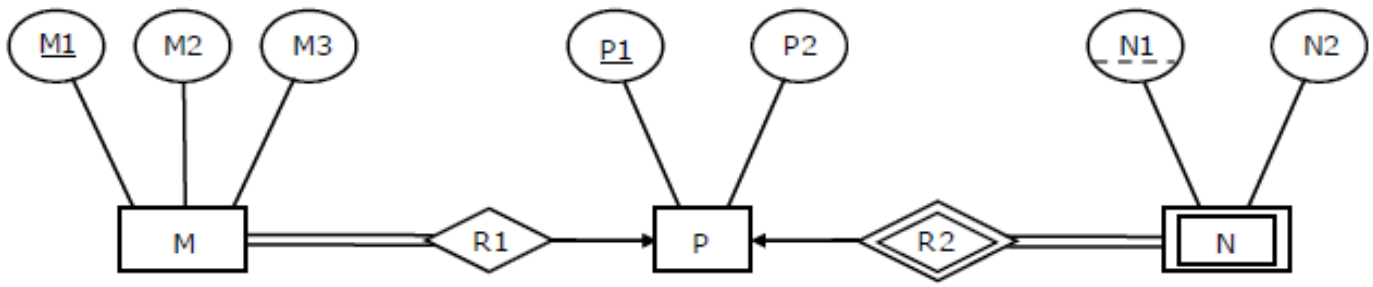
b) Weak entity set avoids the data duplication and consequent possible inconsistencies caused by duplicating the key of the strong entity.

c) A weak entity set has no primary keys unless attributes of the strong entity set on which it depends are included

d) Tuples in a weak entity set are not partitioned according to their relationship with tuples in a strong entity set.

Ans. D

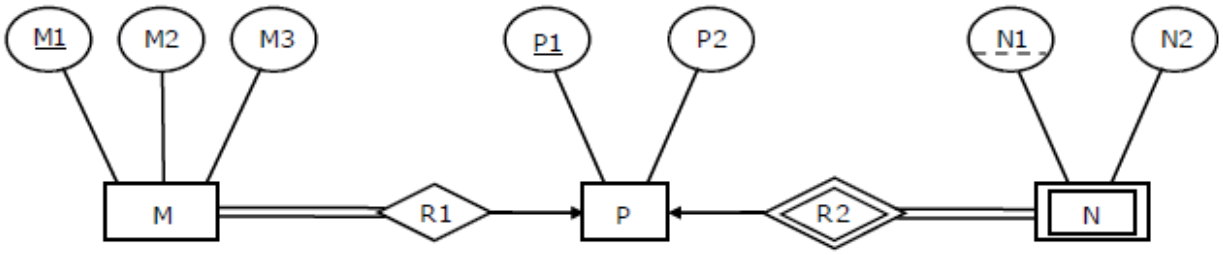
Consider the following ER diagram



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

Ans: 3
(GATE-2008) (2 Marks)

Consider the following ER diagram



Which of the following is a correct attribute set for one of the tables for the correct answer to the above question?

a) {M1, M2, M3, P1}
b) {M1, P1, N1, N2}
c) {M1, P1, N1}
d) {M1, P1}
Ans: a

Q The entity type on which the ..... type depends is called the identifying owner. **(NET-DEC-2004)**
(A) Strong entity
(B) Relationship
(C) Weak entity
(D) E – R
Ans: c

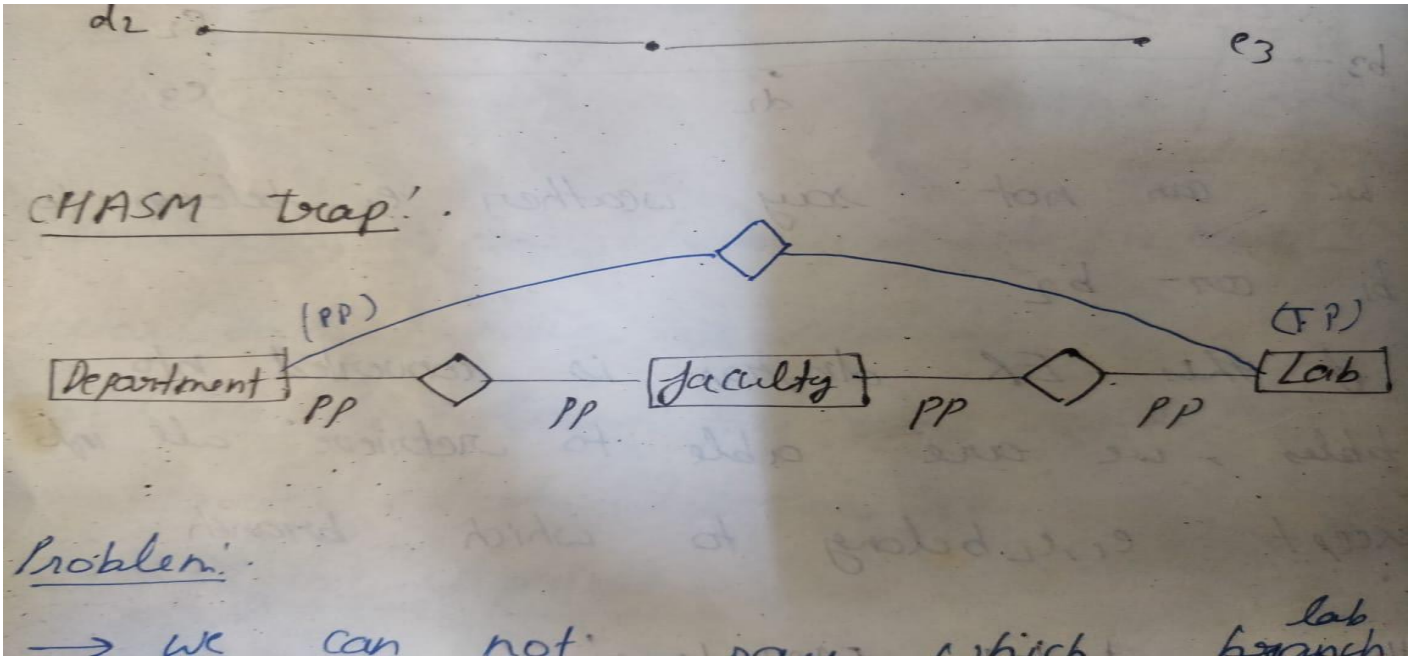
Q Map the following statements with true (T)/false (F)p-
S_1: Participation of the weak entity set in identifying relationship must be total.
S_2: Multi valued attributes in E- R diagram require separate tables when converted into relational model
a) F T **b)** T F **c)** F F **d)** T T

Trapes

- It is possible that even after all efforts there remain some problem with ER diagram. These problems are called trapes. There are two types of trapes in ER diagram.
- **FAN TRAP -** If two or more 1 to M relationships are emerging out from single entity. Then there will be a FAN trap.

- A single site contains many departments and employs many staff. However, which staff work in a particular department
- The fan trap is resolved by restructuring the original ER model to represent the correct association.

- **CHASM TRAP** - If two directly related entities are connected through another(third) entity with partial participation then there is a chasm trap. So, logic suggests the existence of a relationship between entity sets, but the relationship does not exist between certain entity occurrences in ER diagram.
- A model suggests the existence of a relationship between entity types, but the pathway does not exist between certain entity occurrences. Following is the example in different notations.



- **How to eliminate -** Create direct relationship between these 2 entities.

ADVANTAGES OF E-R DIGRAM-

1) Constructs used in the ER diagram can easily be transformed into relational tables.
2) It is simple and easy to understand with minimum training.

DISADVANTAGE OF E-R DIGRAM-

1) Loss of information content
2) Limited constraints representation
3) It is overly complex for small projects