

Database Design Tutorial

HOW TO CREATE AN E-R Diagram

MIS – Database I - ERD

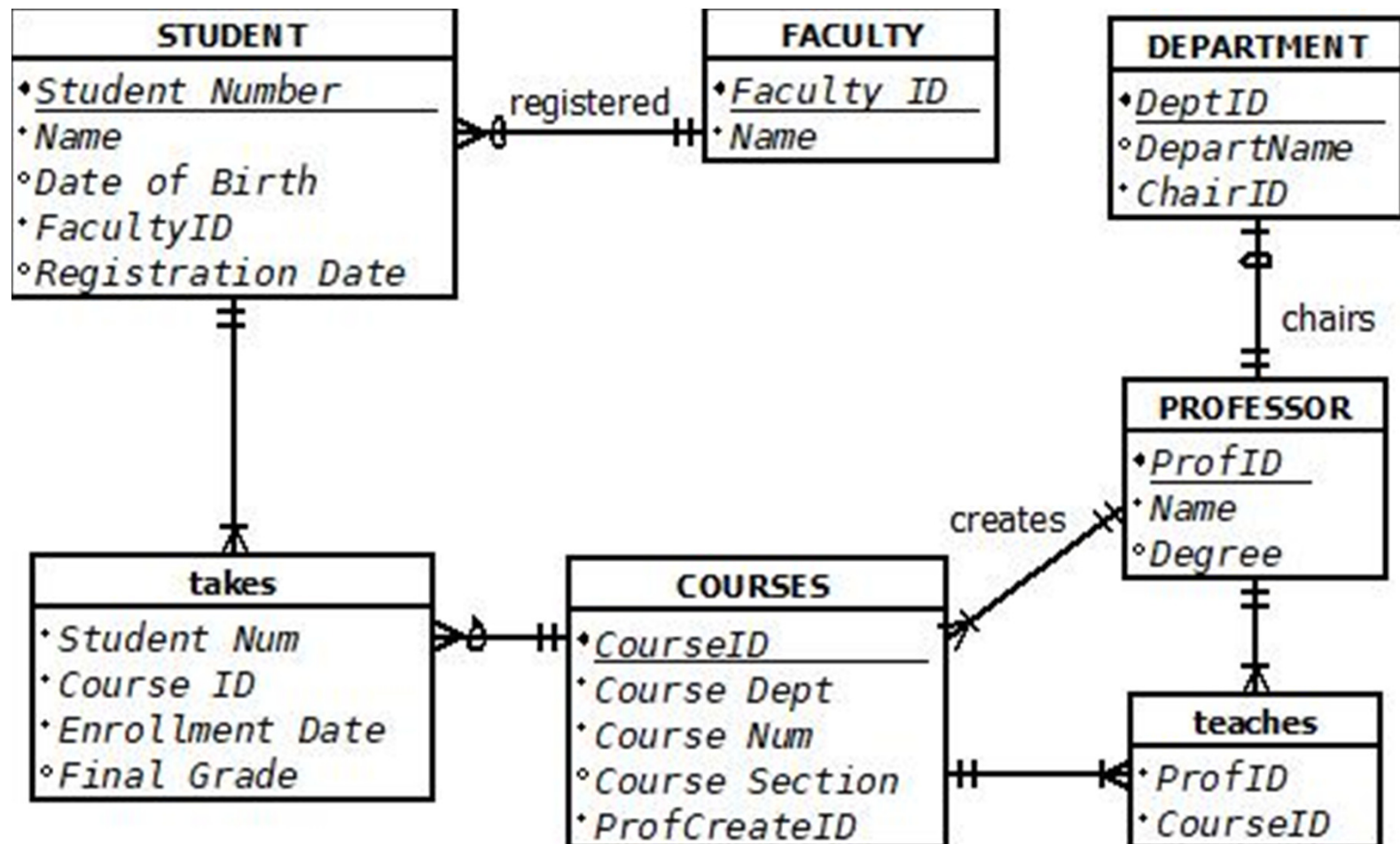
Task

- Create a data repository (database) for:
 - **Western**
 - Track what **courses** are *offered* by which **departments**.
 - Track which **faculty** is each **department** *in*.
 - Track what **courses** the **students** are *enrolled in*
 - Track which **professors** *teach* which **courses**

Use a database to accomplish this task.

MIS – Database I - ERD

Completed E-R Diagram: (tool to create DB)



MIS – Database I - ERD

E-R Symbols

- **Entities** - rectangles

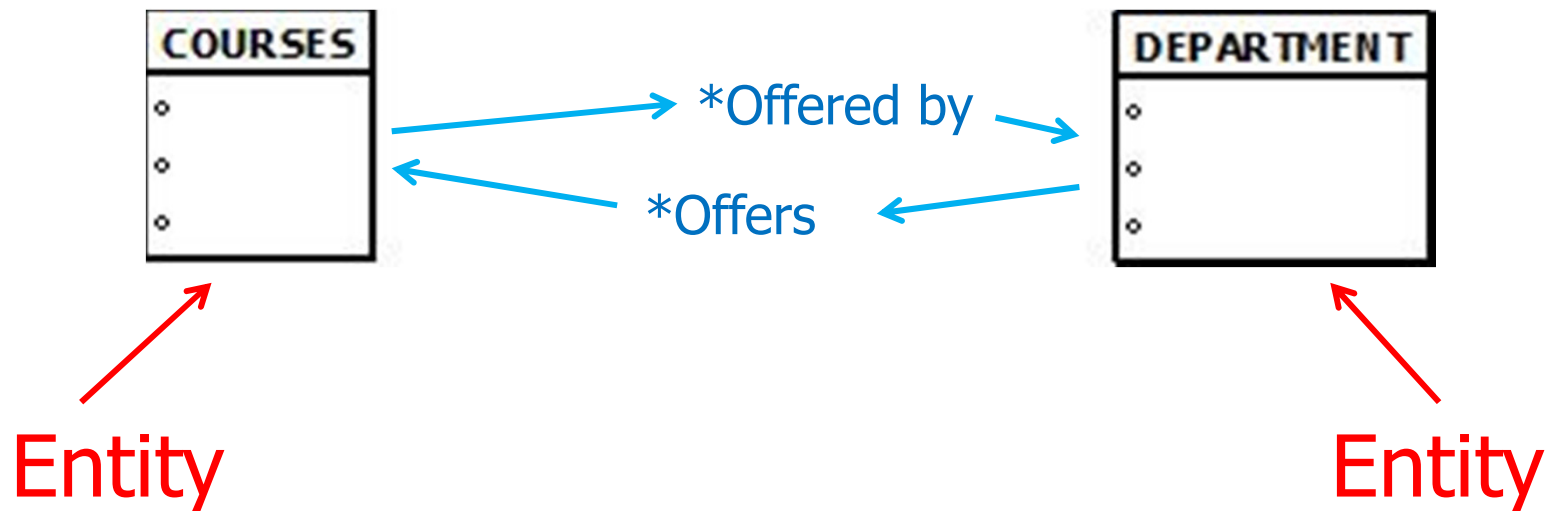
ENTITY NAME

- Entity Attribute 1
- Entity Attribute 2
- Entity Attribute 3

MIS – Database I - ERD

Relationships

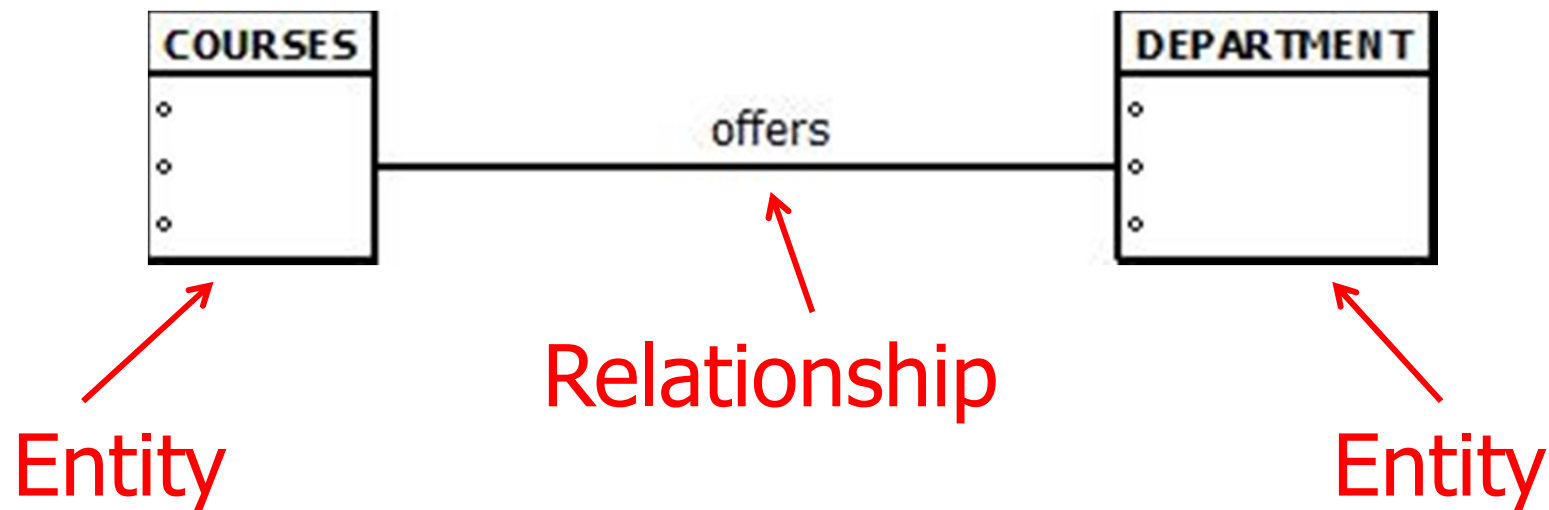
- A relationship:
 - Association between two or more entities
 - Captures how the entities are related to one another



MIS – Database I - ERD

Relationships

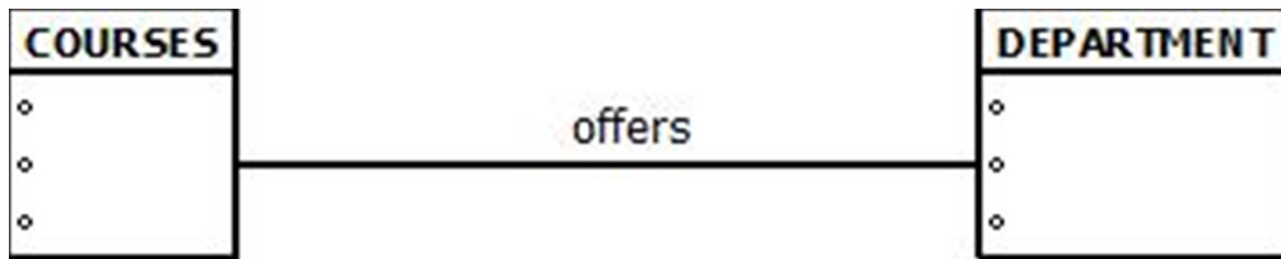
- A relationship:
 - Association between two or more entities
 - Captures how the entities are related to one another



MIS – Database I - ERD

Relationships

- A relationship:
 - Association between two or more entities
 - Captures how the entities are related to one another

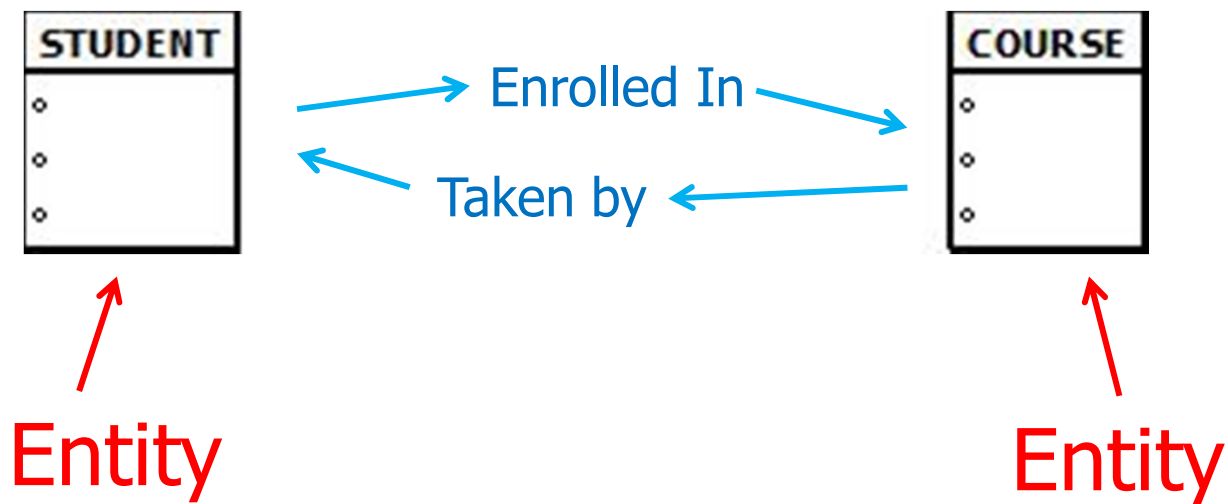


[COURSES offered by DEPARTMENTS]
[DEPARTMENTS offer COURSES]

MIS – Database I - ERD

Relationships

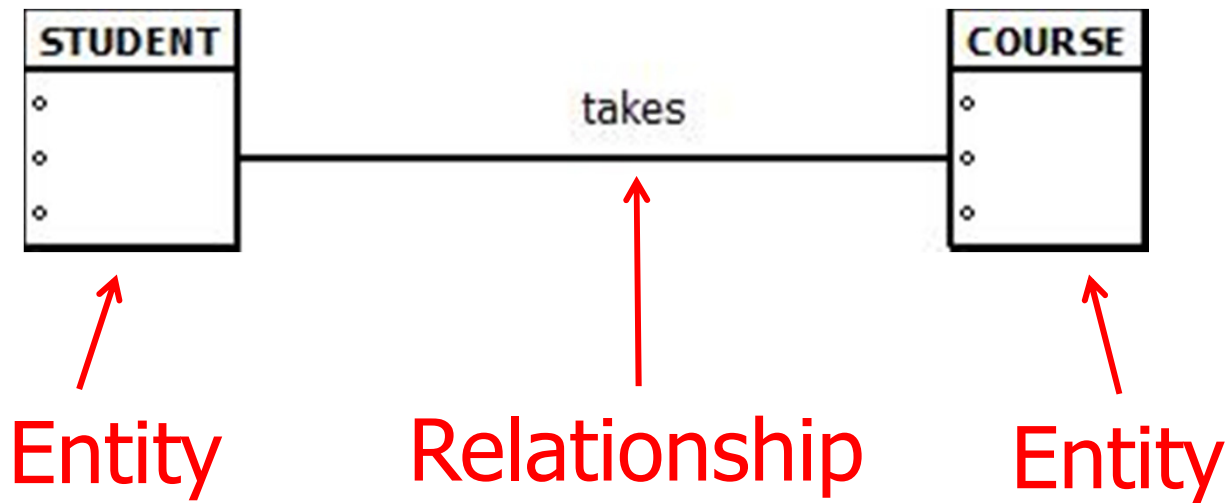
- A relationship:
 - Association between two or more entities
 - Captures how the entities are related to one another



MIS – Database I - ERD

Relationships

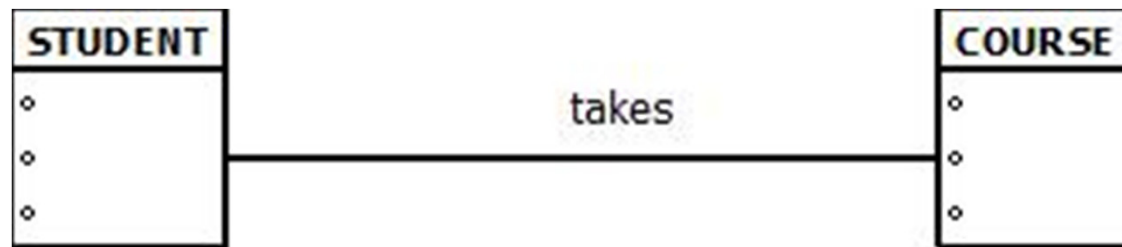
- A relationship:
 - Association between two or more entities
 - Captures how the entities are related to one another



MIS – Database I - ERD

Relationships

- A relationship:
 - Association between two or more entities
 - Captures how the entities are related to one another

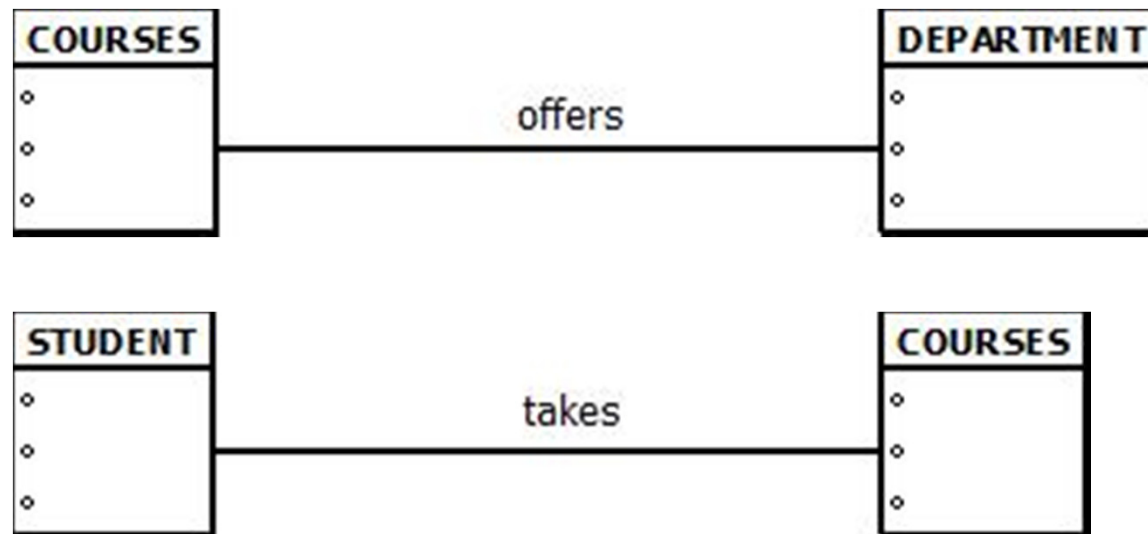


[STUDENT takes (enrolls in) COURSE]
[COURSE taken by STUDENT]

MIS – Database I - ERD

Relationships

- A relationship:
 - **Association** between two or more entities
 - Captures how the entities are **related** to one another



MIS – Database I - ERD

Relationships

- A relationship:
 - Association between two or more entities
 - Captures how the entities are **related** to one another



Attributes

- All Entities have attributes
- Describe properties of the entity

- **Example:**

- Student Attributes:

Student number,
Name,
Address,
Phone number,
Date of birth

Course Attributes:

Department,
Faculty,
Course Number,
Section

Primary Keys - (Key Attributes)

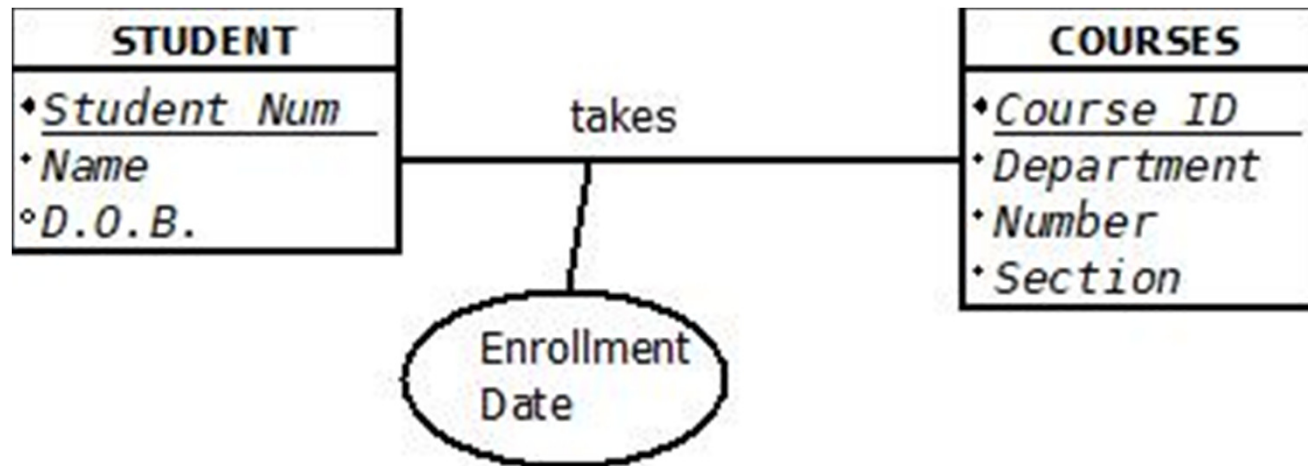
- Necessary to *uniquely* identify the instance of each entity
- Examples:
 - SIN
 - student numbers
 - employee numbers

Attributes

- **Relationships** also can have attributes
- Describe **properties** of the relationship
 - these properties are not associable to either Entity

MIS – Database I - ERD

Attributes



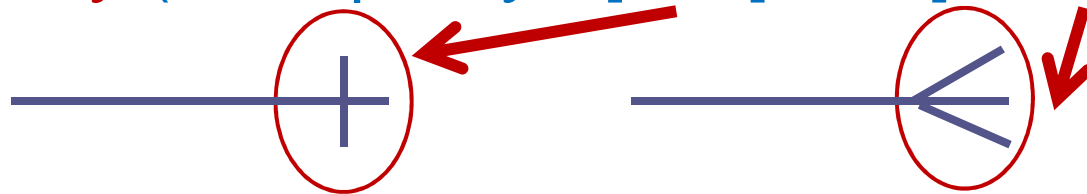
Instances

- Database contains instances of the entities
 - an instance is the actual data entered in the attributes of an Entity
- Just as Attributes **describe** the entity
 - an instance is one set of attributes filled in
- **Example**: an instance of the student entity
 - 250078563 (student ID)
 - Isma Braneful (name)
 - 65-927 Richmond Street (address)
 - 519-555-4562 (phone)
 - 05/11/1998 (date of birth)

Relationships

- Relationships have two descriptive facets

- Cardinality (Multiplicity - [one] -or- [many]):



- Participation Level ([optional] -or- [mandatory]):



MIS – Database I - ERD

Relationships

One and ONLY One



(Only One Instance BUT Mandatory)

Zero or One



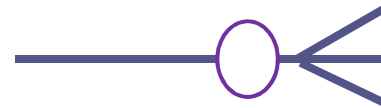
(Only One Instance BUT Optional)

One or Many



**(One or More Instance
BUT Mandatory)**

Zero or Many



**(One or More Instance
BUT Optional)**

Cardinality

- Indicates the **number** of instances of the entities that are **involved in the relationship**

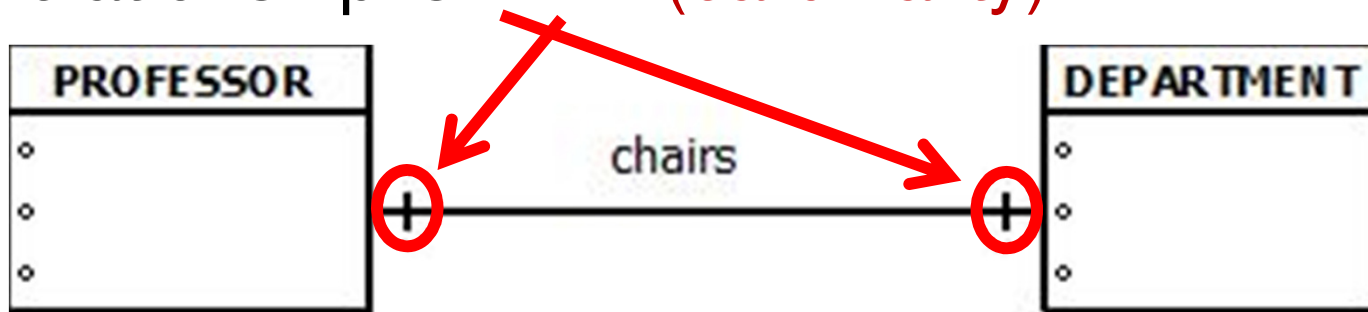
Cardinality

- 1:1 relationships
 - Single entity instance to single entity instance
- 1:N (N:1) relationships
 - One to many
 - Single entity instance to many entity instances
- **N:M** relationships
 - Many to many
 - Many entity instances to many entity instances

MIS – Database I - ERD

1:1 Relationship

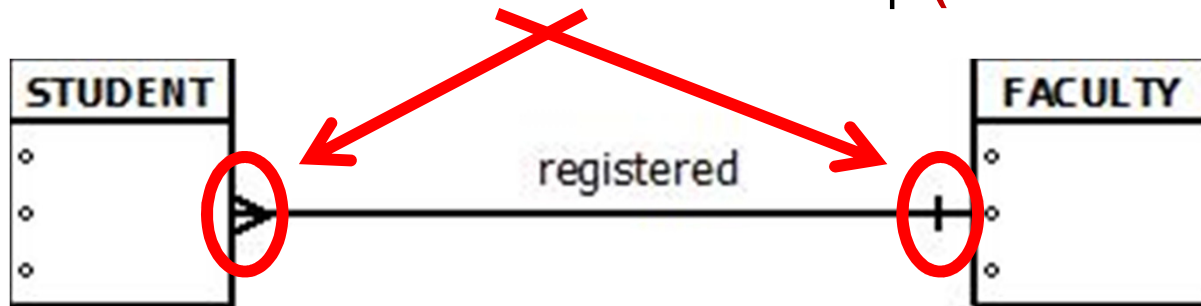
- Relationship exist:
 - Professor is the chair of a Department
- Relationship is:
 - A PROFESSOR can be chair of only **one** DEPARTMENT
 - Each DEPARTMENT can have only **one** chair
- Relationship is **1:1** (cardinality)



MIS – Database I - ERD

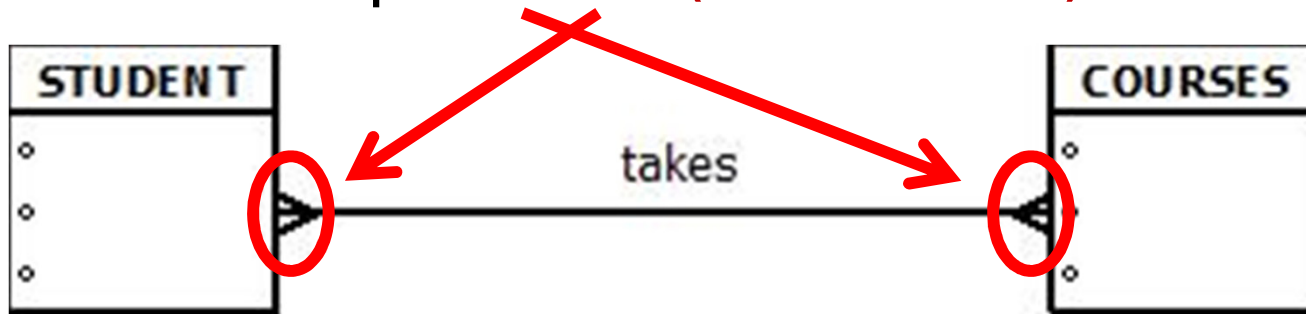
1:N Relationship

- Relationship exists:
 - Student registered in a Faculty
- Relationship is:
 - STUDENT is only registered in **one** FACULTY
 - FACULTY can have **many** STUDENTS registered
 - The many students is indicated by N
- Therefore this is a **1 : N** relationship (**CARDINALITY**)



N:M Relationship

- Relationship exists:
 - Students taking courses
- Relationship is:
 - STUDENT can take **many** courses, N
 - COURSE can be taken by **many** students, M
- Relationship is **N:M (CARDINALITY)**



MIS – Database I - ERD

Quick Question



Read as:

An student is registered in _____ faculty(s)

(Fill in the blank with 1 or M)

A faculty has _____ student(s) registered in it

(Fill in the blank with 1 or M)

Participation (a.k.a. Modality -or- Multiplicity)

- The participation of an entity in a relationship indicates whether **all** or only **some** of the instances of the entity are involved in the relationship

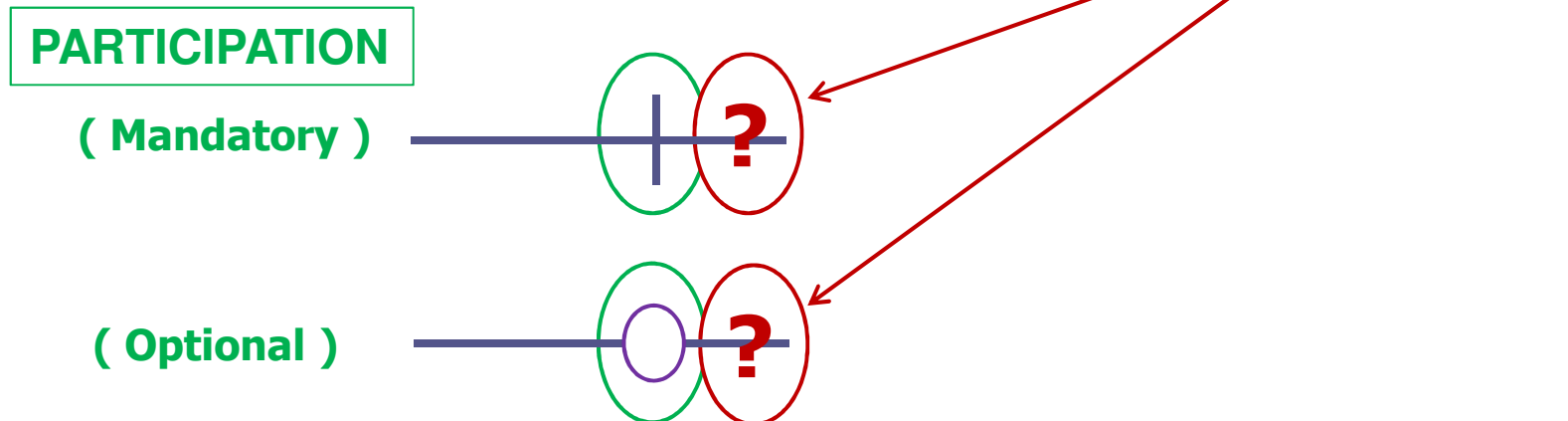
Participation

- “**Mandatory**” participation:
 - **All** of the instances are involved in the relationship
- “**Optional**” participation:
 - If **NOT all** of the instances are involved in the relationship

MIS – Database I - ERD

E-R Symbols

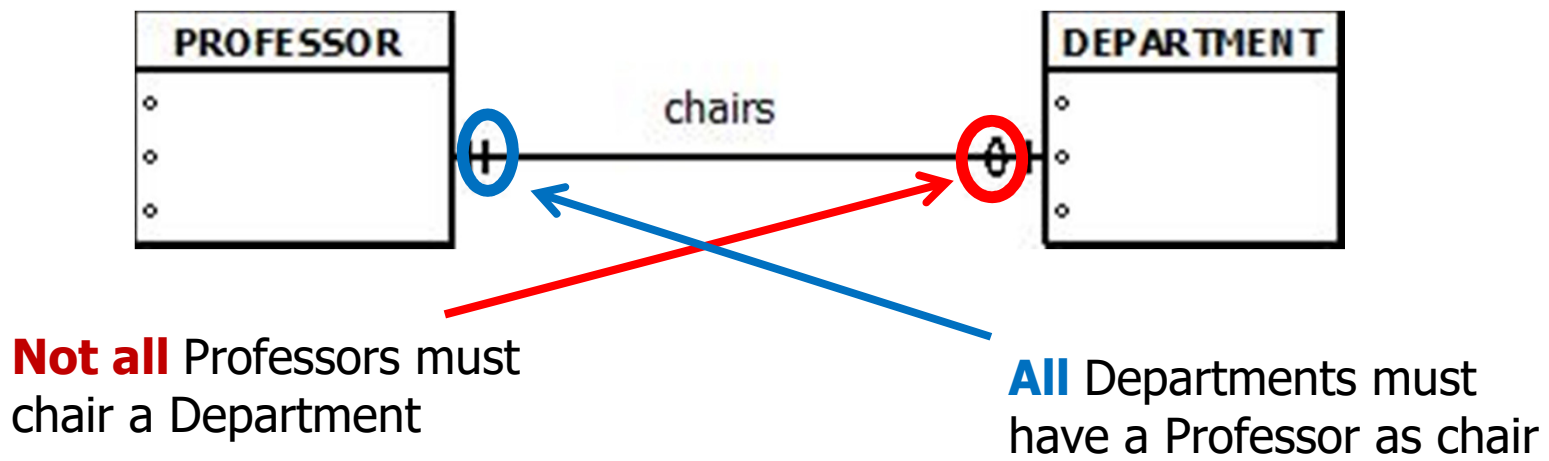
- **Participation** represented:



MIS – Database I - ERD

Participation - EXAMPLE ONE (1)

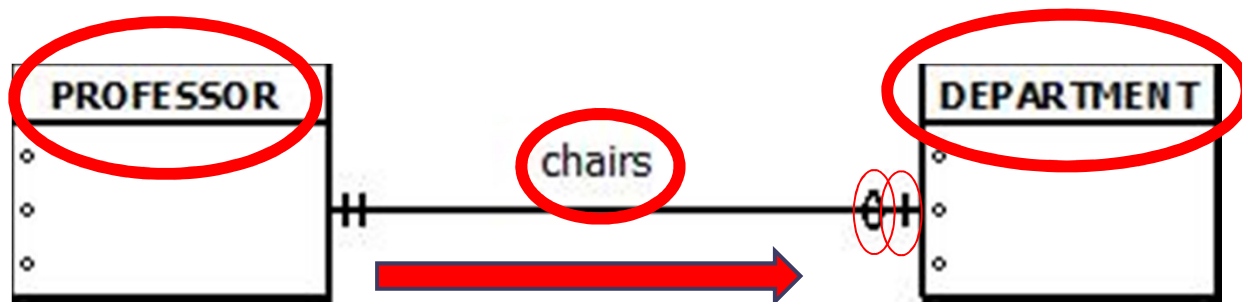
- Relationship: **PROFESSOR** chairs **DEPARTMENT**
 - **Not all** Professors are Department Chairs
 - Participation of Professor: **Optional**
 - **All** Departments must have as chair a Professor
 - Participation of Department: **Mandatory**



MIS – Database I - ERD

Relationship - EXAMPLE ONE (1)

- HOW TO READ A CROW'S FOOT DIAGRAM.
a **PROFESSOR** can (optionally) be a chair of one
and only one **DEPARTMENT**

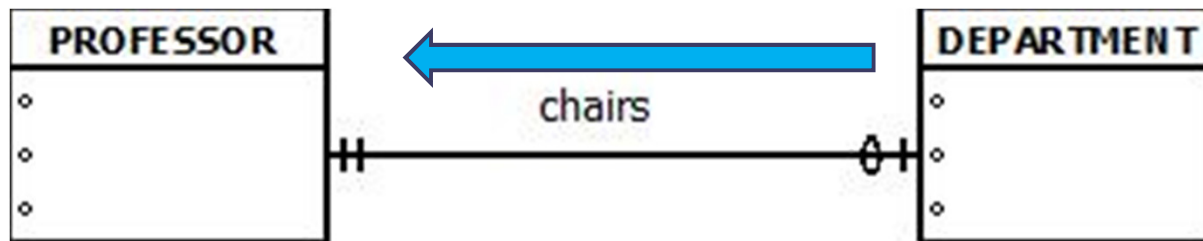


ENTITY - PARTICIPATION - RELATIONSHIP - CARDINALITY - ENTITY

MIS – Database I - ERD

Relationship - EXAMPLE ONE (1)

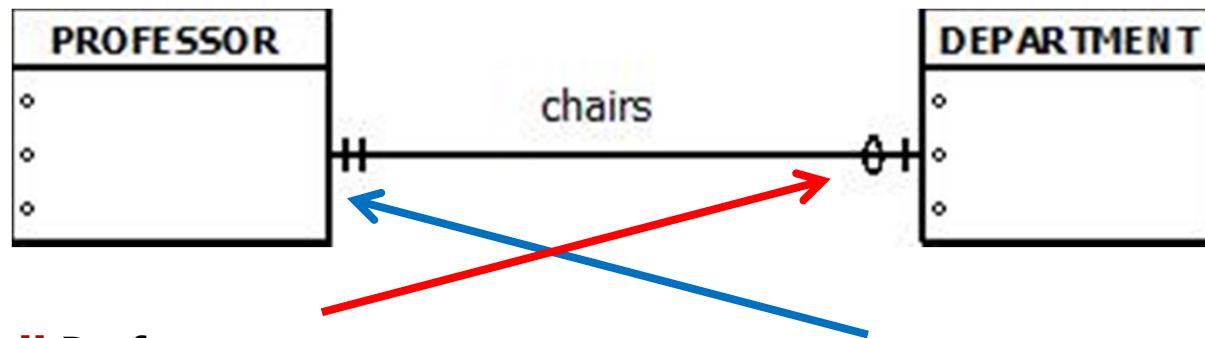
- Relationship: PROFESSOR chairs DEPARTMENT
 - Not all Professors are Department Chairs
 - Participation of Professor: **Optional**
 - All Departments must have as chair a Professor
 - Participation of Department: **Mandatory**



- so: a DEPARTMENT must have as its chair one PROFESSOR and One Professor ONLY !

MIS – Database I - ERD

- Relationship: PROFESSOR chairs DEPARTMENT



Not all Professors must chair a Department

All Departments must have a Professor as chair

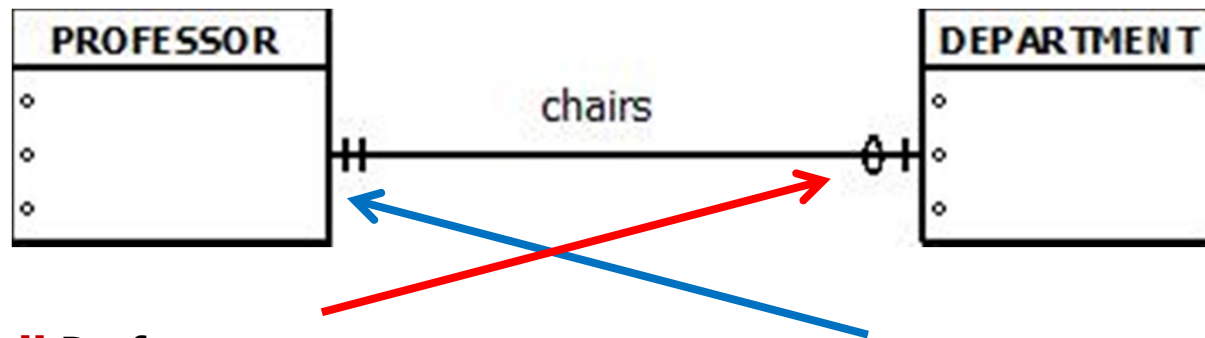
SO:

IF a new member 'Zima' is entered as an instance of PROFESSOR
THEN there does NOT have to be an instance in DEPARTMENT associated.

i.e. [PROFESSOR] **Zima** can be entered into the database without
the need to add a 'connection' to [DEPARTMENT]

MIS – Database I - ERD

- Relationship: PROFESSOR chairs DEPARTMENT



Not all Professors must chair a Department

All Departments must have a Professor as chair

BUT:

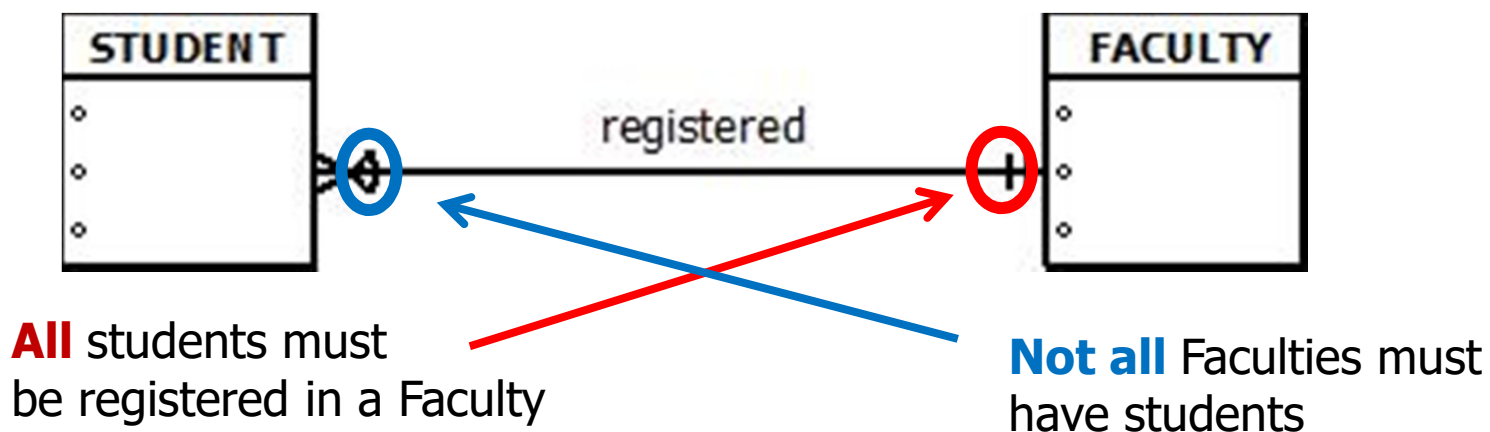
IF a new department 'Science' is entered as an instance of DEPARTMENT
THEN there **must** be an instance in PROFESSOR associated with it.

i.e. [DEPARTMENT] **Science** associated (related) to [PROFESSOR] **Maggs**
- a 'connection' **MUST** be established.

MIS – Database I - ERD

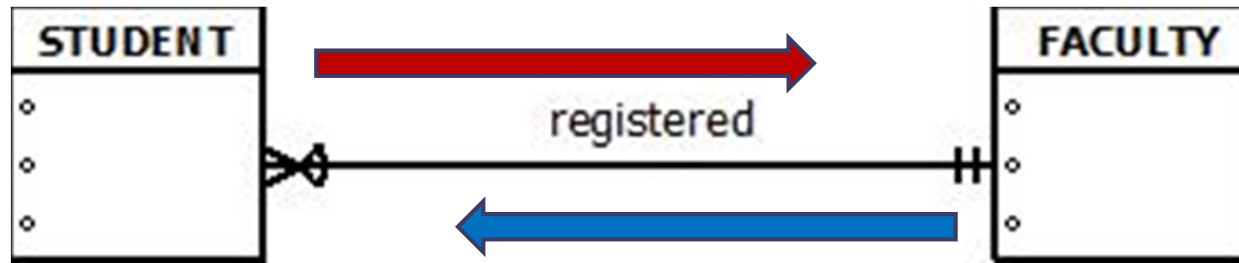
Participation - EXAMPLE TWO (2)

- Relationship: **STUDENT** registered in **FACULTY**
 - **Not all** Faculties must have students
 - Participation of Faculty: **Optional**
 - **All** students must be registered in a Faculty
 - Participation of Student: **Mandatory**



MIS – Database I - ERD

- Relationship: **STUDENT** registered in **FACULTY**



All students must
be registered in a Faculty

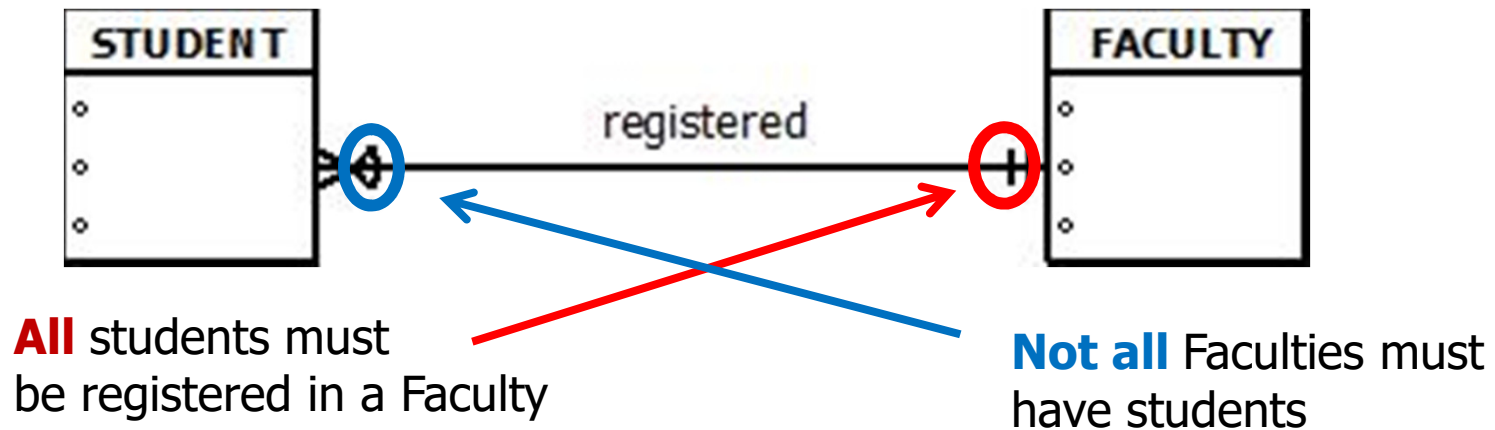
Not all Faculties must
have students

**A STUDENT must be (mandatory) registered in one
and only one FACULTY**

**a FACULTY can have (optional) registered in it
zero or one or many STUDENTS**

MIS – Database I - ERD

- Relationship: **STUDENT** registered in **FACULTY**



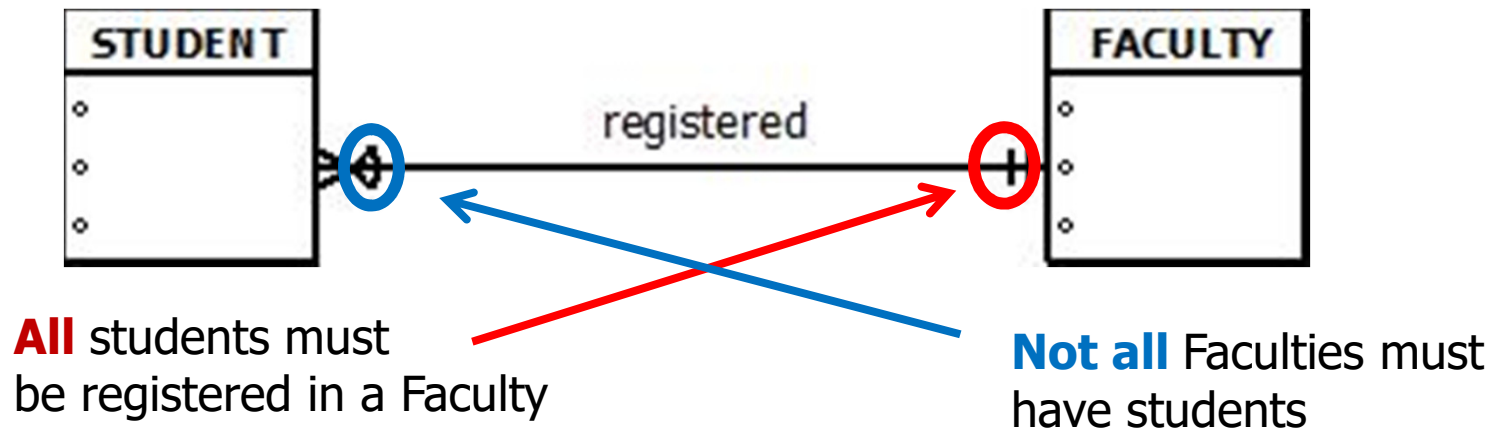
SO:

IF a new student 'Fred' is entered as an instance of **STUDENT**
THEN there must be an instance in **FACULTY** associated with it.

i.e. [**STUDENT**] **Fred** associated (related) to [**FACULTY**] **Science**

MIS – Database I - ERD

- Relationship: **STUDENT** registered in **FACULTY**



BUT:

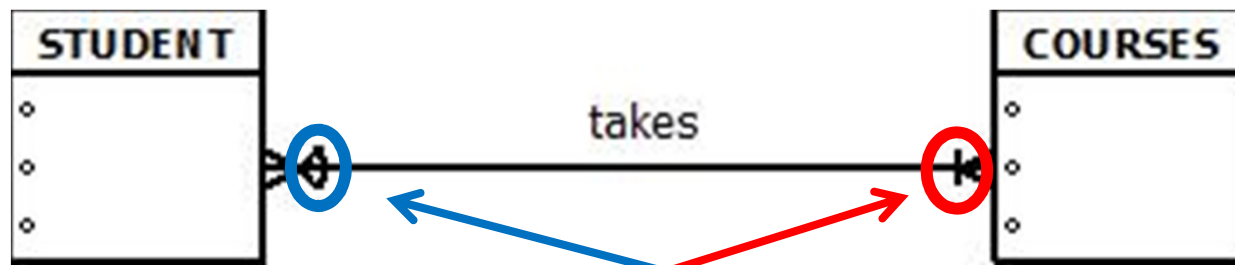
IF a new FACULTY 'Modernity' is entered as an instance of FACULTY
THEN it is possible that no instance in STUDENT associated with it.

i.e. [FACULTY] **Modernity** has NO associated (related) [STUDENT]

MIS – Database I - ERD

Participation - EXAMPLE THREE (3)

- Relationship is: **STUDENT** takes **COURSE**
 - All** Students must take courses
 - Participation of Student: **Mandatory**
 - Courses **do not** have to have students registered in them
 - Participation of Course: **Optional**



All students must
be enrolled in Course(s)

Not all Courses must
have students enrolled

MIS – Database I - ERD

- Relationship: **STUDENT** takes **COURSE**



All students must be enrolled in Course(s)

Not all Courses must have students enrolled

A STUDENT must take one or more COURSES

a COURSE can have enrolled (taking) zero or more STUDENTS

MIS – Database I - ERD

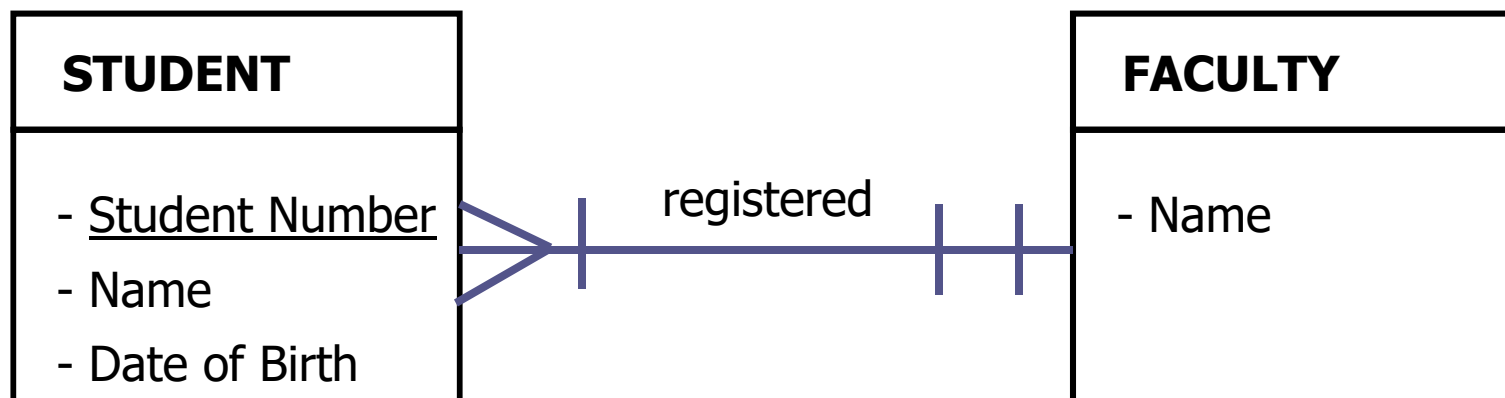
Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Entities - rectangles

Attributes - properties

Primary Key - identifier



MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

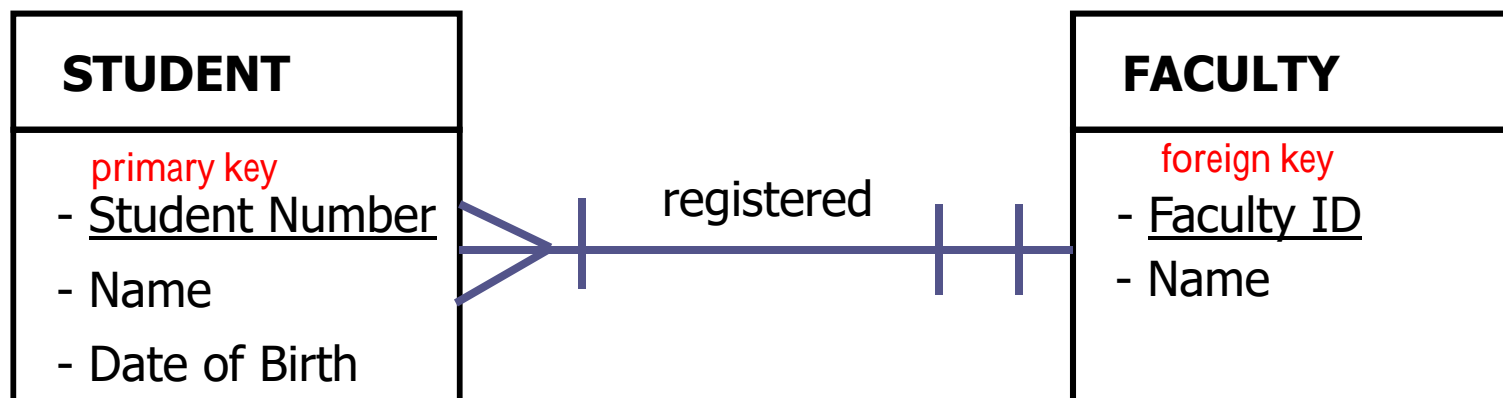
Entities - rectangles

Attributes - properties

Primary Key - identifier

- **Create the relationship**

**Primary Key - Foreign Key
Match up.**



MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

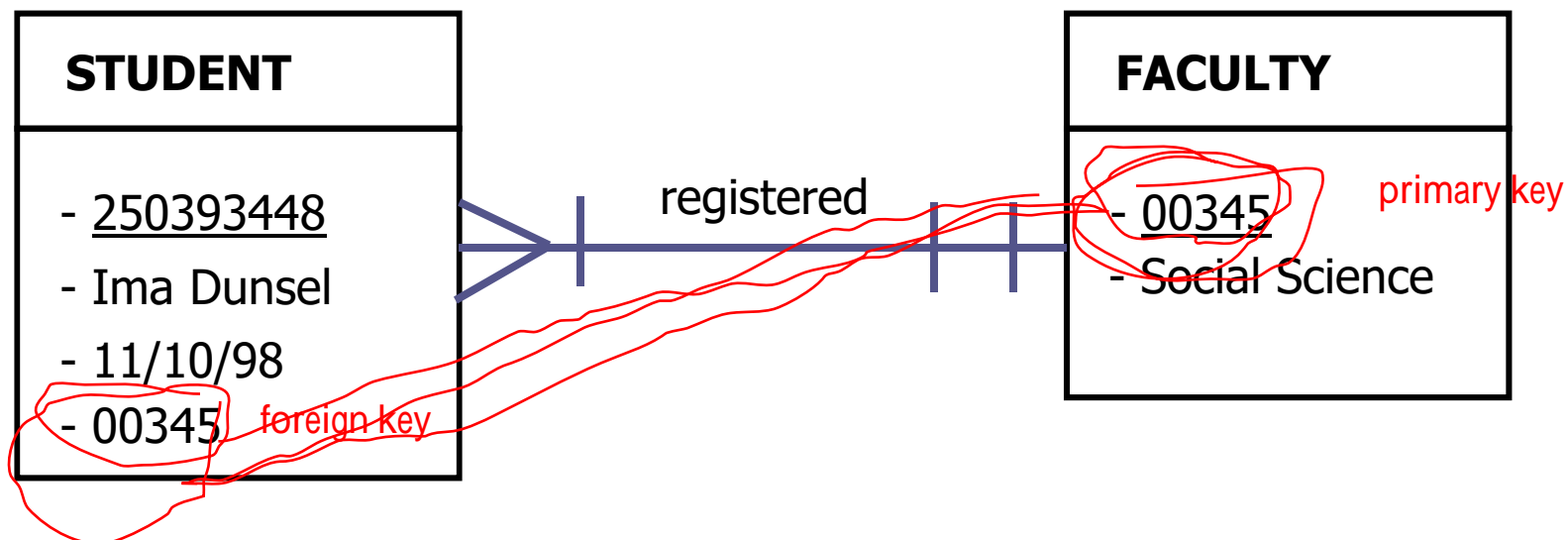
Entities - rectangles

Attributes - properties

Primary Key - identifier

- **Create the relationship ???**

**Primary Key - Foreign Key
Match up.**



Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Entities - rectangles

Attributes - properties

Primary Key - identifier

How to identify which is **Primary and which is **Foreign** ?**

Which entity gets the Foreign Key?

(where to put it ?)

What to name the Foreign Key?

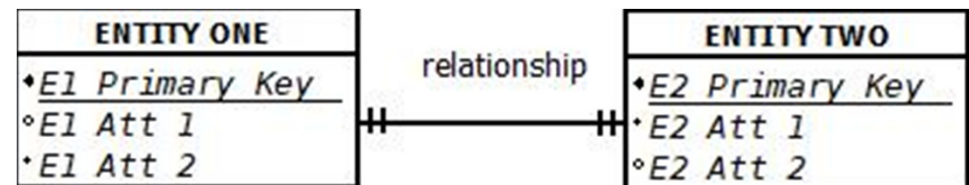
MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

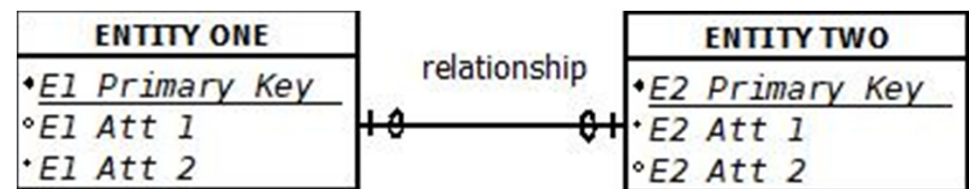
Relationship is 1:1 (then check **Participation**)

if both sides are **Mandatory**



-or-

both sides are **Optional**



MIS – Database I - ERD

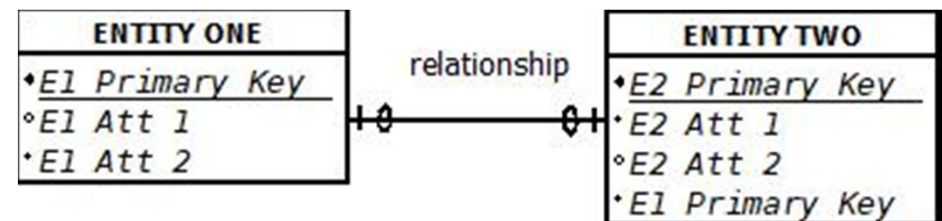
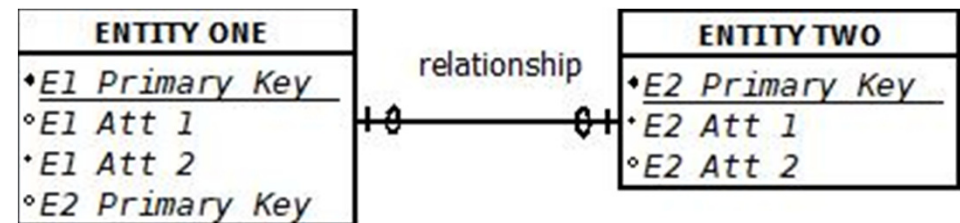
Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is **1:1**

if both sides are
Mandatory -or- Optional

(then it does not matter which entity receives the foreign key)



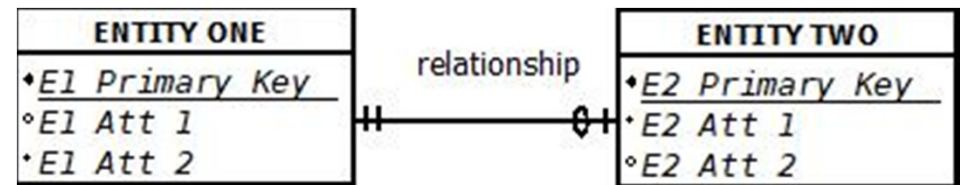
MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is 1:1 [BUT !]

if only one side is Mandatory
- and -
the other side is Optional



MIS – Database I - ERD

Completing the E-R Model/Diagram

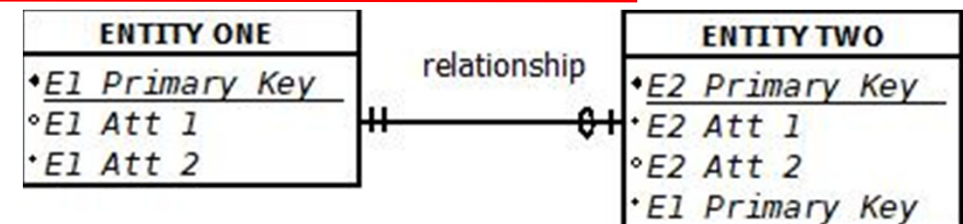
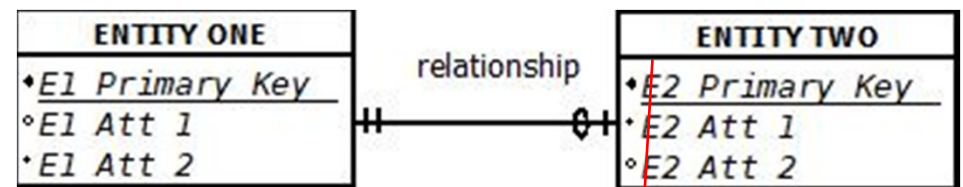
Attributes and Relationship Connectors

Relationship is 1:1

if only one side is **Mandatory**
- and -
the other side is **Optional**

(then the **MANDATORY** entity must receive the foreign key)

(**CAUTION:** remember which
is the mandatory entity ...)



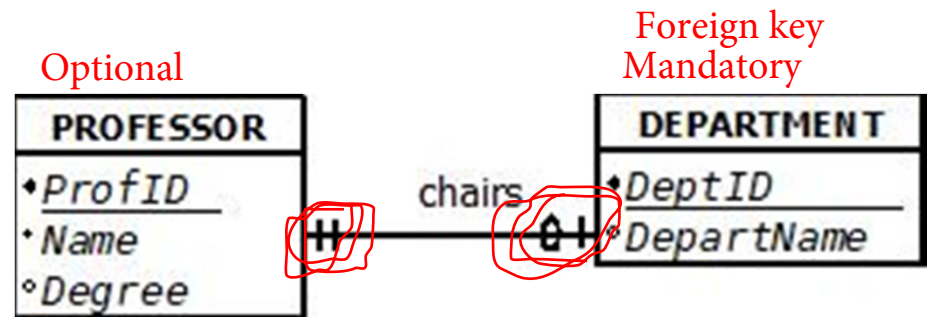
MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is 1:1

if only one side is **Mandatory**
 - and -
 the other side is **Optional**



The professor id is the primary key and the foreign key to the department.

It is important to make sure the foreign key

MIS – Database I - ERD

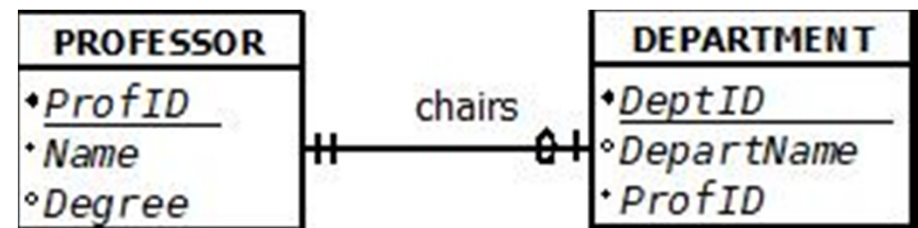
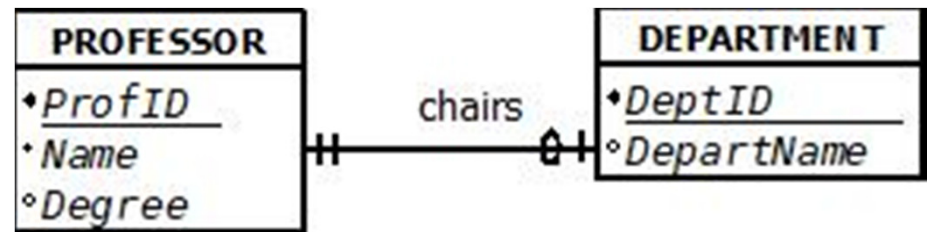
Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is 1:1

if only one side's **Mandatory**
- and -
the other side is **Optional**

(then the **MANDATORY** entity must receive the foreign key)



MIS – Database I - ERD

Completing the E-R Model/Diagram

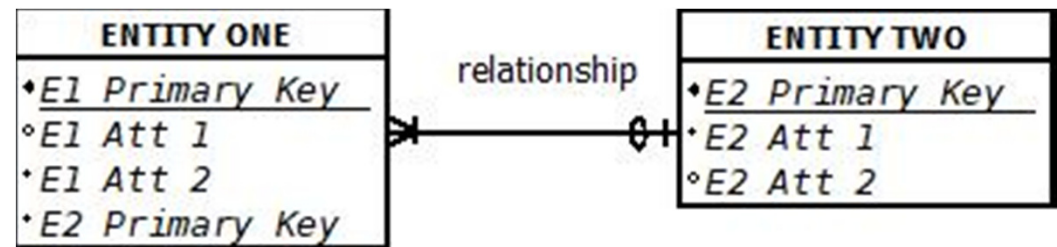
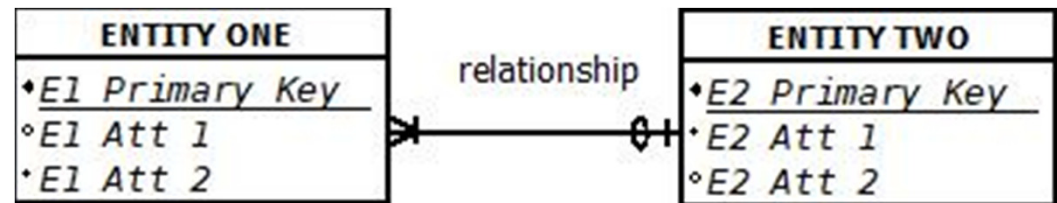
Attributes and Relationship Connectors

Relationship is 1:N

if only one side's **Many**
- and -

the other side is **One**

(then the **ONE** entity must receive the foreign key)



MIS – Database I - ERD

Completing the E-R Model/Diagram

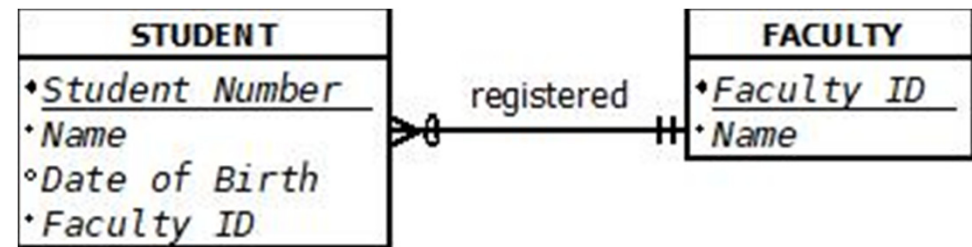
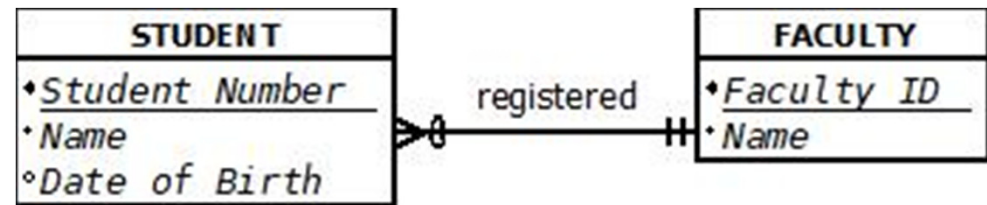
Attributes and Relationship Connectors

Relationship is 1:N

if only one side's **Many**
- and -

the other side is **One**

(then the **ONE** entity must receive the foreign key)



MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

e.g students must have a faculty
and a faculty can have many student

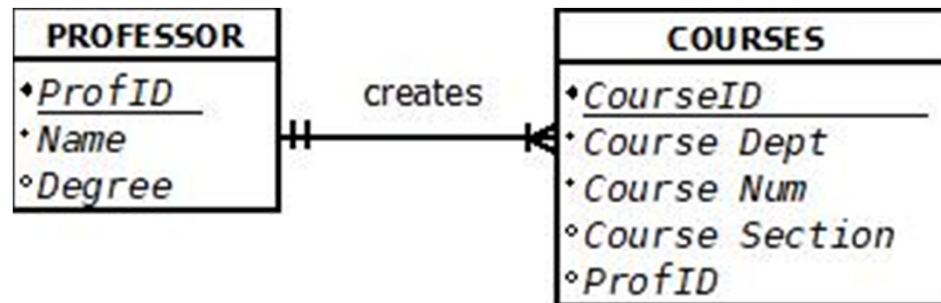
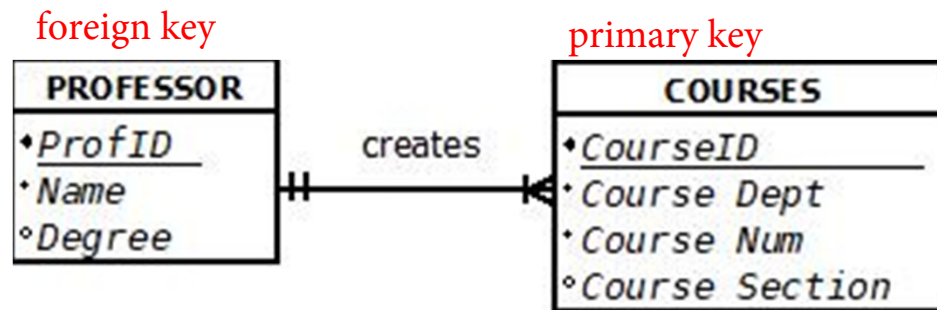
Relationship is 1:N

if only one side's **Many**
- and -

the other side is **One**

(then the **ONE** entity must receive the foreign key)

the professor create many courses
the course is created by one professor



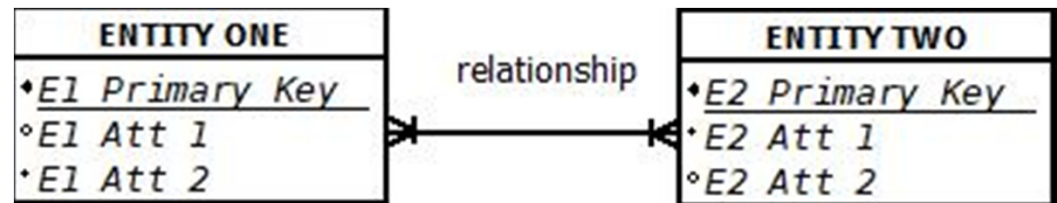
MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is **N:M**

if both sides are **Many**
this is a **SPECIAL** case !



a new (connector) ENTITY
must be created

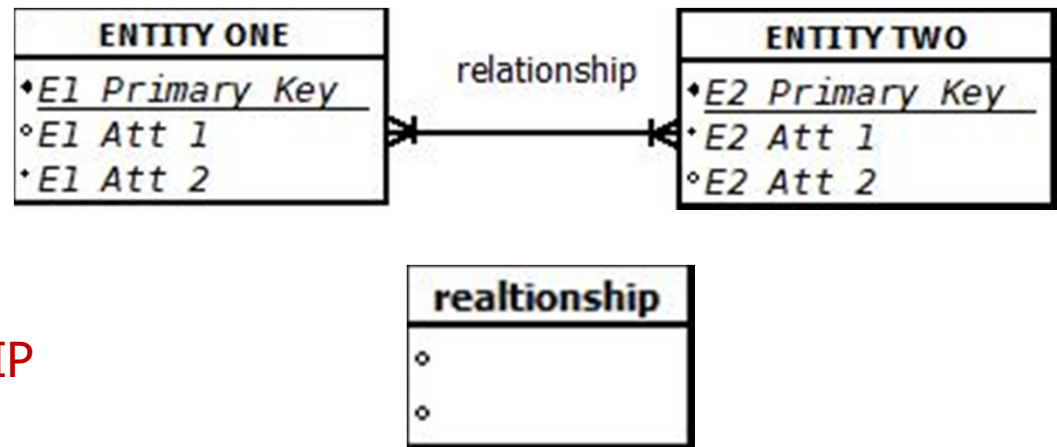
MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is **N:M**

if both sides are **Many**



- named after the **RELATIONSHIP**

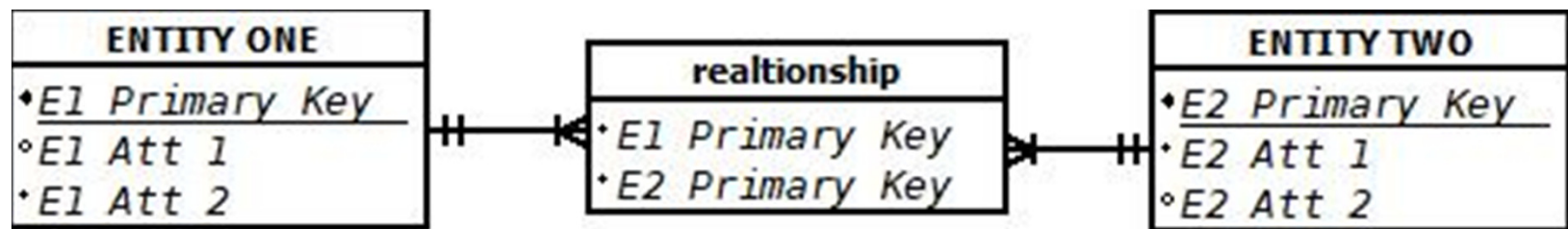
MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is **N:M**

if both sides are **Many**



- Connect this by using two **1:N** connections

MIS – Database I - ERD

Completing the E-R Model/Diagram

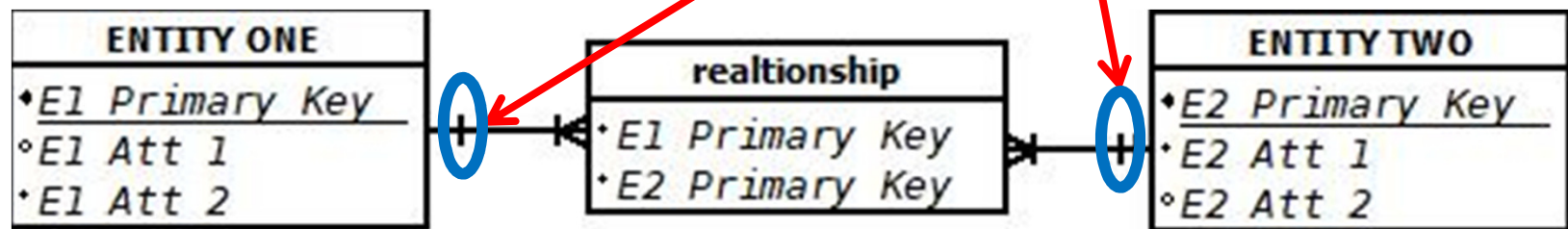
Attributes and Relationship Connectors

Relationship is **N:M**

if both sides are **Many**

NOTE: Participation

1.) always **MANDATORY** to the connector entity



- Connect this by using two
1:N connections

MIS – Database I - ERD

Completing the E-R Model/Diagram

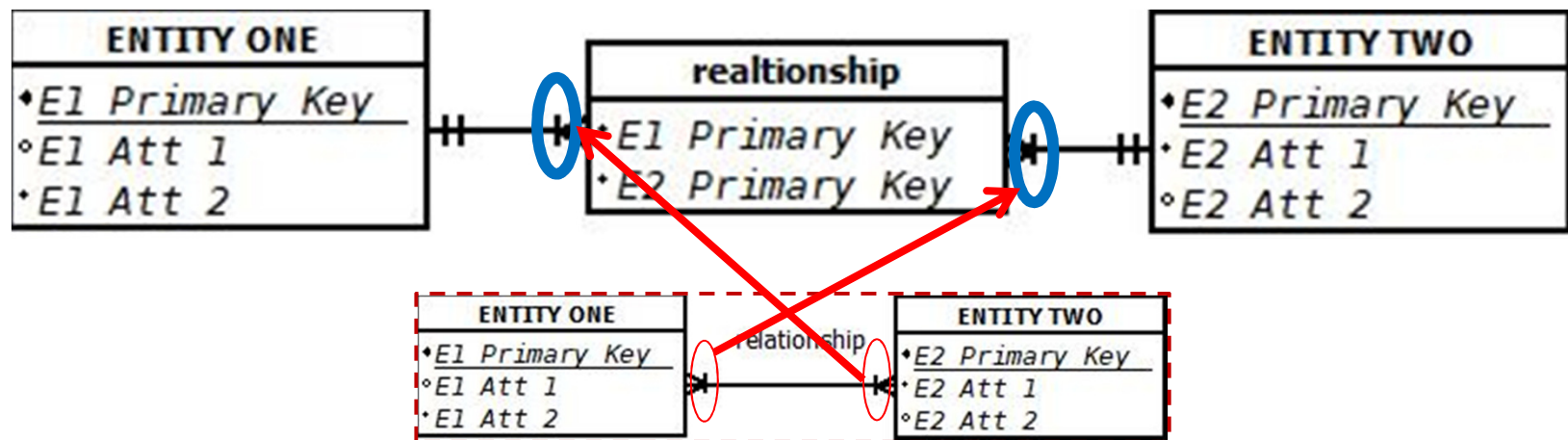
Attributes and Relationship Connectors

Relationship is **N:M**

NOTE: Participation

2.) must **match** (be copied from) the original relationship

if both sides are **Many**



MIS – Database I - ERD

Completing the E-R Model/Diagram

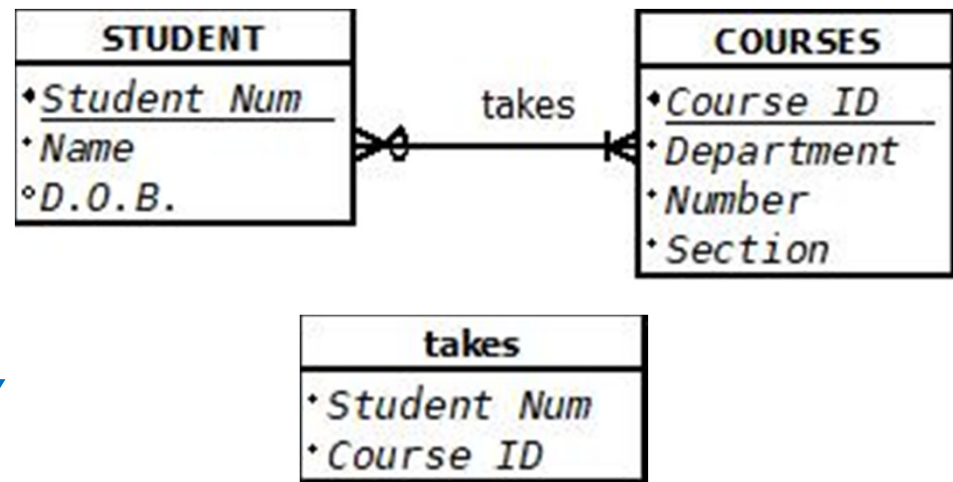
Attributes and Relationship Connectors

Relationship is **N:M**

if both sides are **Many**
this is a SPECIAL case !

a new (connector) ENTITY
must be created

- named after the RELATIONSHIP



MIS – Database I - ERD

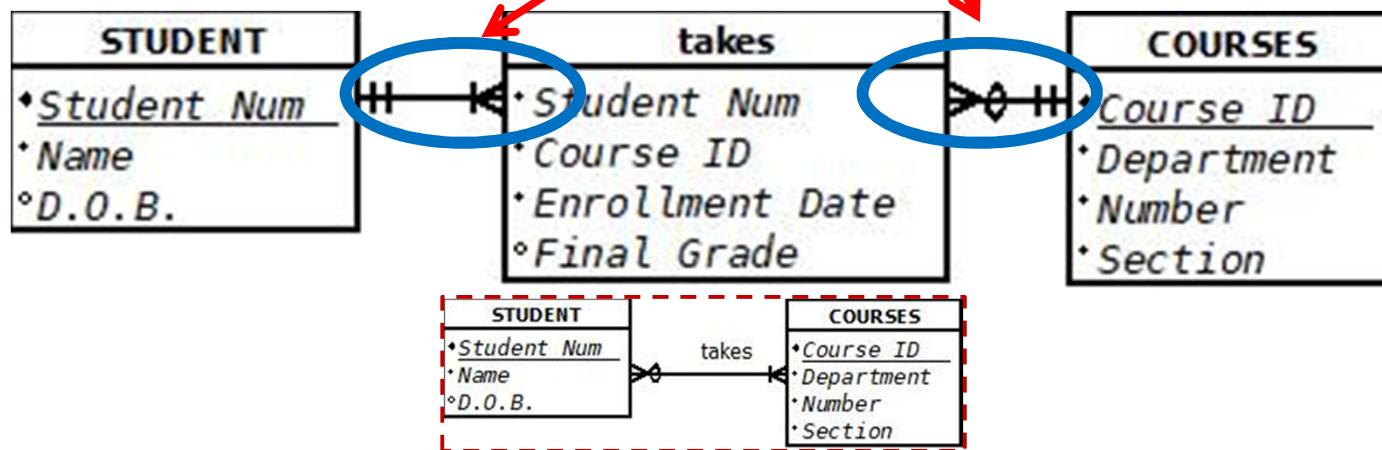
Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is **N:M**

if both sides are **Many**

- Connect this by using two **1:N** connections



MIS – Database I - ERD

Completing the E-R Model/Diagram

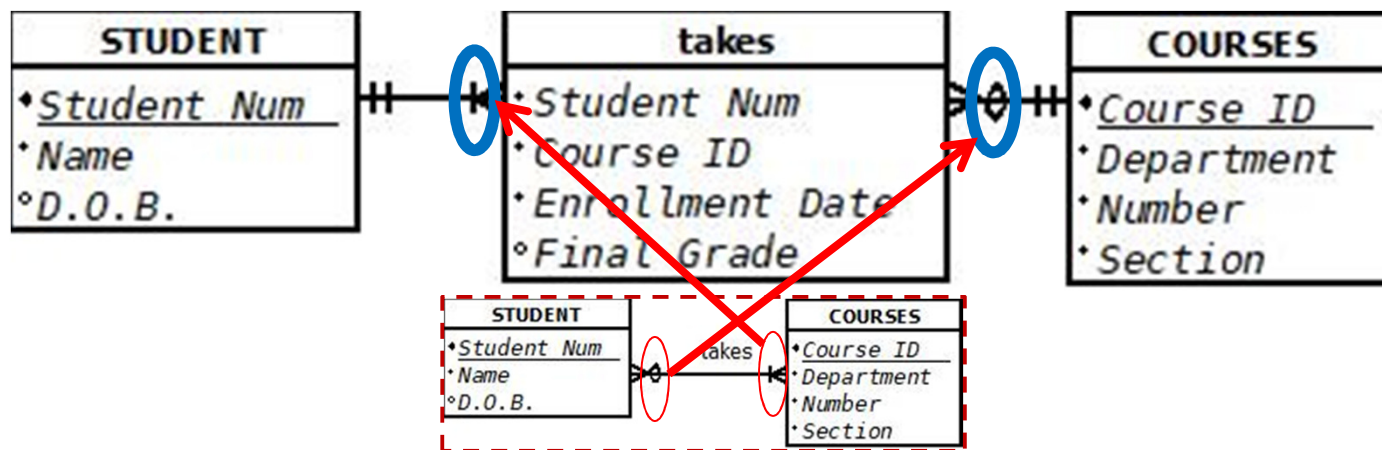
Attributes and Relationship Connectors

Relationship is **N:M**

NOTE: Participation

2.) must **match** (be copied from) the original relationship

if both sides are **Many**



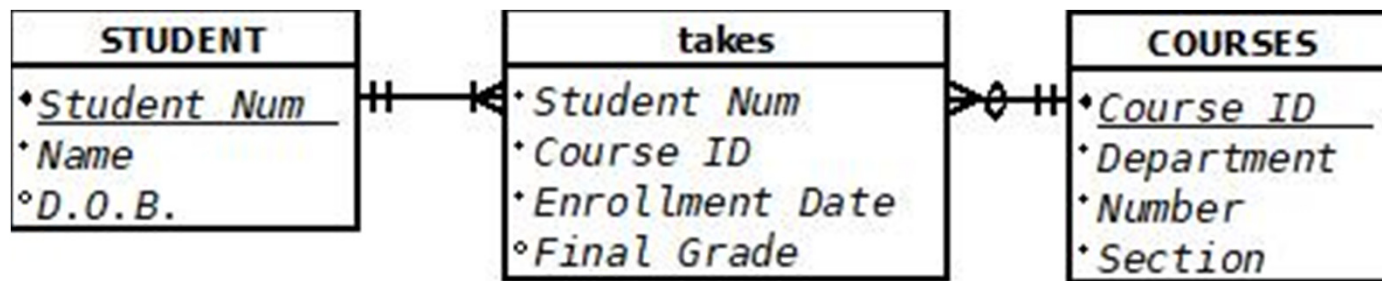
MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes and Relationship Connectors

Relationship is **N:M**

if both sides are **Many**



Completing the E-R Model/Diagram

Attributes OF Relationship Connectors

- **Relationships** also can have attributes
- Describe **properties** of the relationship

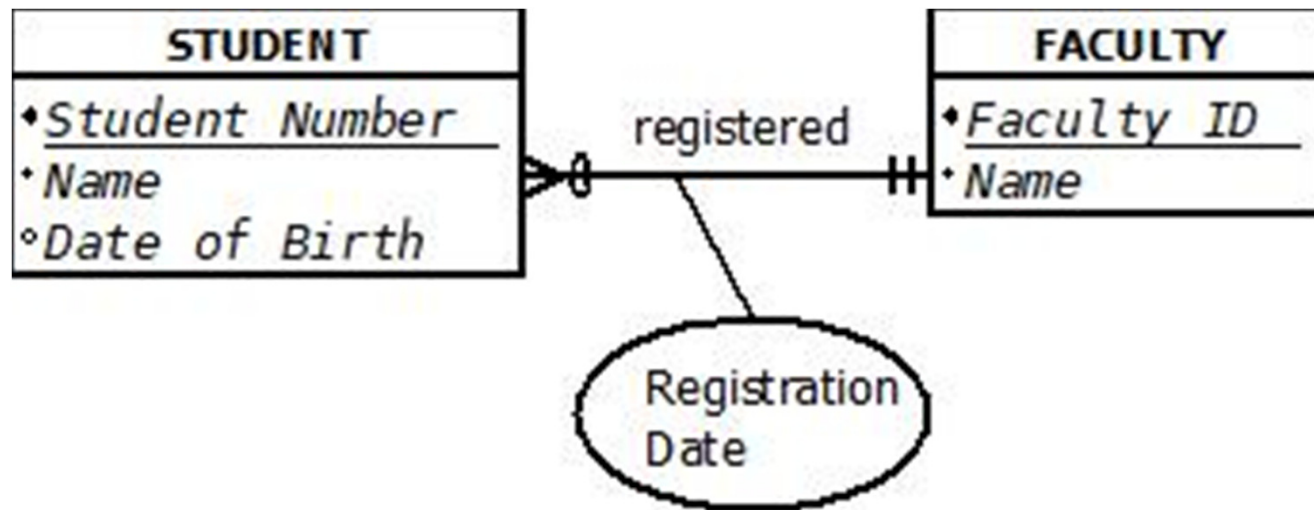
Example:

- STUDENT registered in FACULTY:
 - Registration date for the student is a **detail** that describes the relationship
 - Registration date does not describe the student or the faculty

MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes OF Relationship Connectors

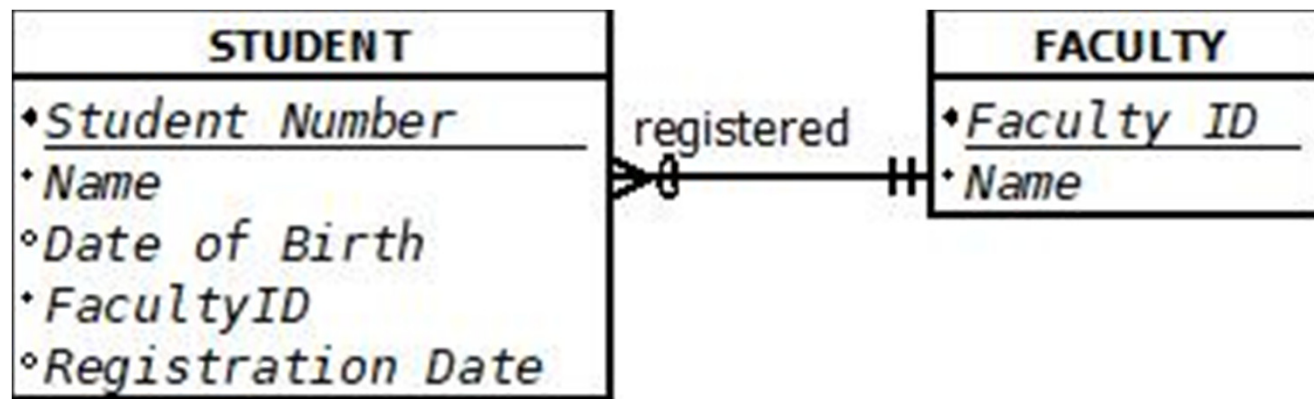


relation attribute always follows the foreign key.

MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes OF Relationship Connectors



- This is a **1:N** connection : so **Primary** from MANY entity becomes **Foreign** in the ONE entity

Completing the E-R Model/Diagram

Attributes OF Relationship Connectors

- **Relationships** also can have attributes
- Describe **properties** of the relationship

Example:

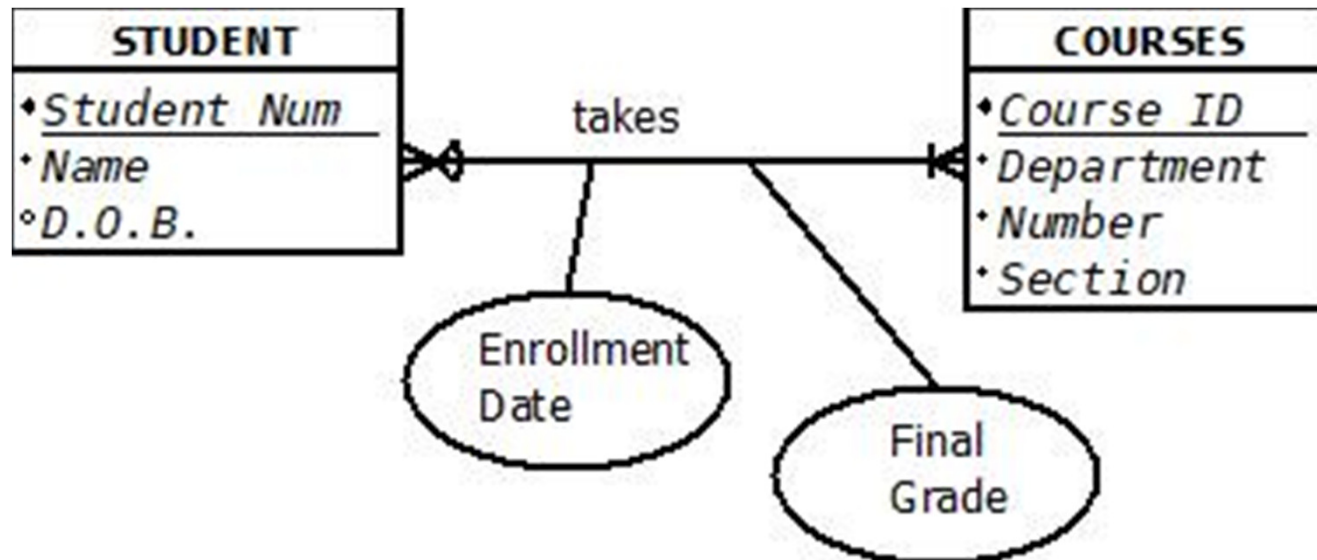
▫ STUDENT Takes COURSE:

- Enrollment date for the person is a **detail** that describes the relationship
- Student's final grade in the course
- Enrollment date and grade does not describe the student or the course

MIS – Database I - ERD

Completing the E-R Model/Diagram

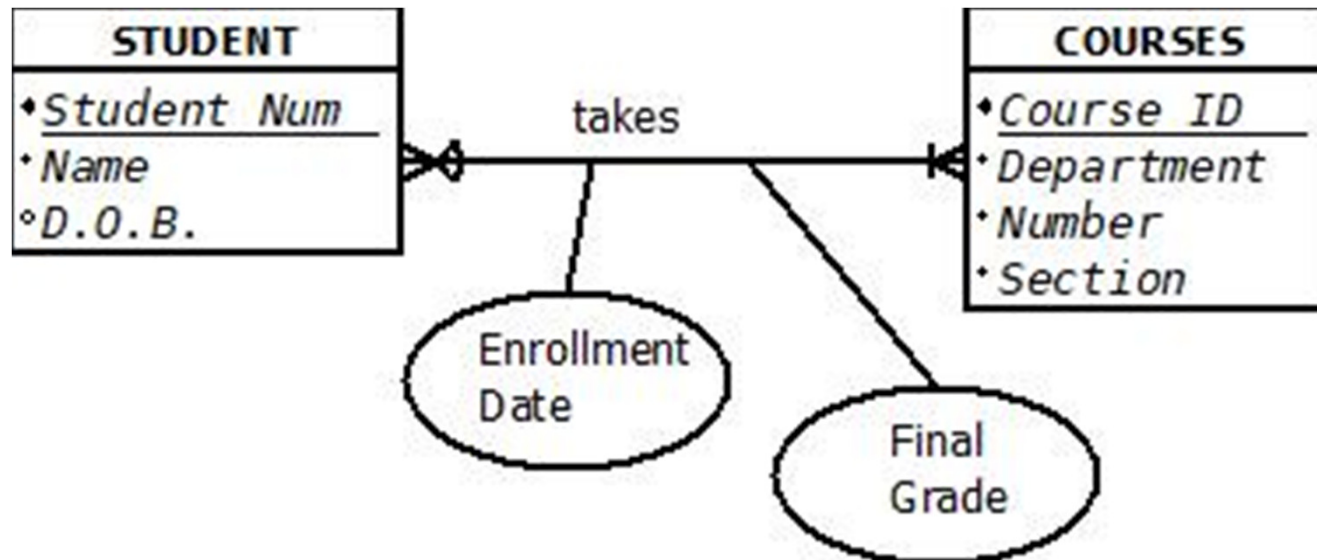
Attributes OF Relationship Connectors



MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes OF Relationship Connectors



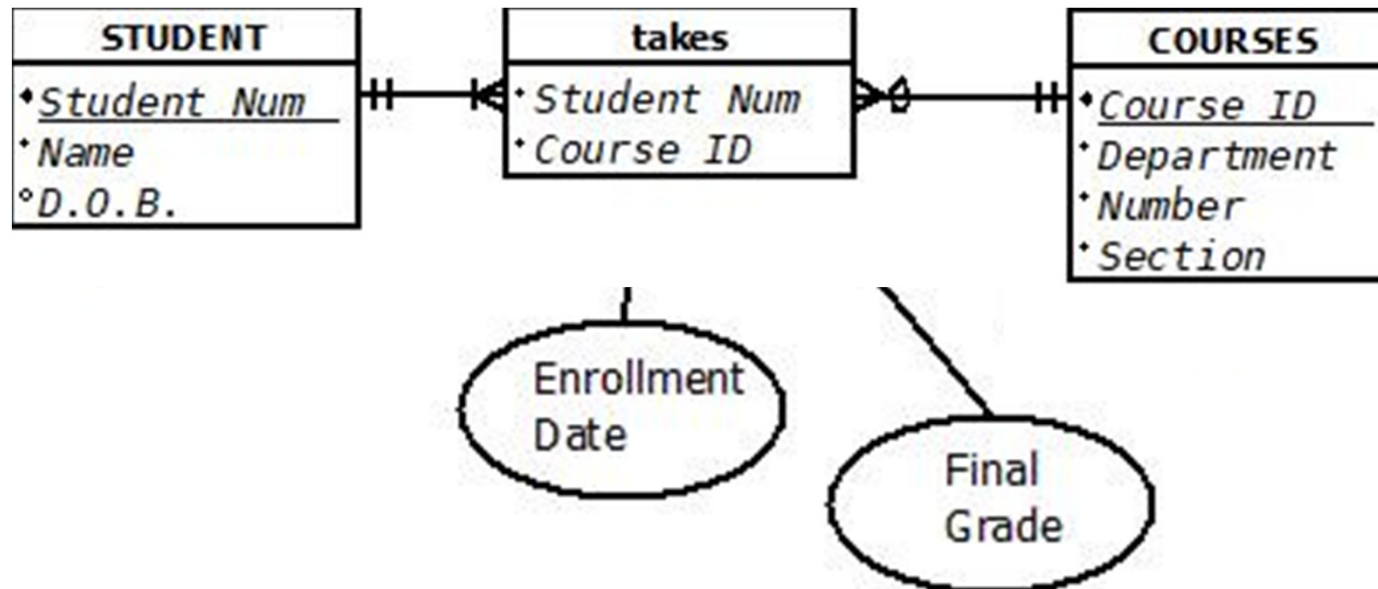
Relation attribute always follows the foreign key

- This is a **M:N** connection : so **Primary** from both entities becomes **Foreign** keys in the new **takes** relationship entity

MIS – Database I - ERD

Completing the E-R Model/Diagram

Attributes OF Relationship Connectors



- This is a **M:N** connection : so **Primary** from both entities becomes **Foreign** keys in the new **takes** relationship entity

MIS – Database I - ERD

Completing the E-R Model/Diagram

