

Entity/Relationship Modelling

Database Systems

In This Lecture

- Entity/Relationship models
 - Entities and Attributes
 - Relationships
 - Attributes
 - E/R Diagrams
- For more information
 - Connolly and Begg chapter 11
 - Ullman and Widom chapter 2

Data Modeling

- **Data modeling** is often the first step in database design as the designers first create a conceptual **model** of how **data** items relate to each other. **Data modeling** involves a progression from conceptual **model** to logical **model** to physical schema.
- Data modeling refers to describing the relationship between entities.
- Models can be built for existing systems as a way to better understand those systems, or for proposed systems as a way to document business requirements or technical designs.
- One way to structure unstructured problems is to draw models.

Categories of data models

- **Conceptual (high-level, semantic)** data models: Provide concepts that are close to the way many users *perceive* data. (Also called **entity-based** or **object-based** data models.)
- **Logical Data Models (LDMs)**: Entity types, data attributes and relationships between entities
- **Physical Data Models**: Describes HOW the system will be implemented using a specific DBMS.

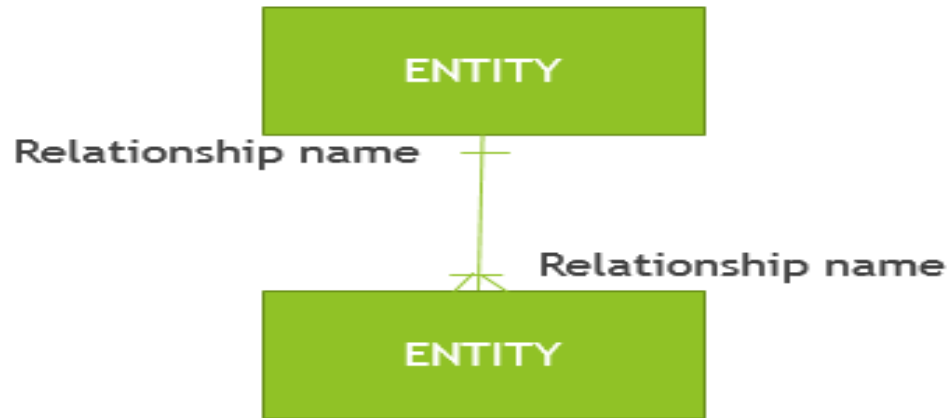
Entities

- An entity might be
- An object with physical existence. E.g. a lecturer, a student, a car
- An object with conceptual existence. E.g. a course, a job, a position
- Entity Type: The entity type can be defined as a name/label assigned to items/objects that exist in an environment and that have similar properties. Collection of similar entities define a type of an entity.
- For example Students is a Entity Type.
- Entity Instance: Ahmed is a Entity instance of Entity Type Student.

Entities

Entity Types	Properties	Instances
EMPLOYEE	Human being, has name, has father name, has a registration number, has qualification, designation	M. Sharif, Sh. Akmal and many others
FURNITURE	Used to sit or work on, different material, having legs, cost, purchased	Chair, table etc.
ELECTRIC APPLIANCES	Need electricity to work, purchased	Bulb, fan, AC
OFFICE EQUIPMENT	Used for office work, consumable or non- consumable.	Papers, pencil, paper weight etc.

- A data model consists of entities related to each other on a diagram:



Data Model Element	Definition
Entity	A real world thing or an interaction between 2 or more real world things.
Attribute	The atomic pieces of information that we need to know about entities.
Relationship	How entities depend on each other in terms of why the entities depend on each other (the relationship) and what that relationship is (the cardinality of the relationship).

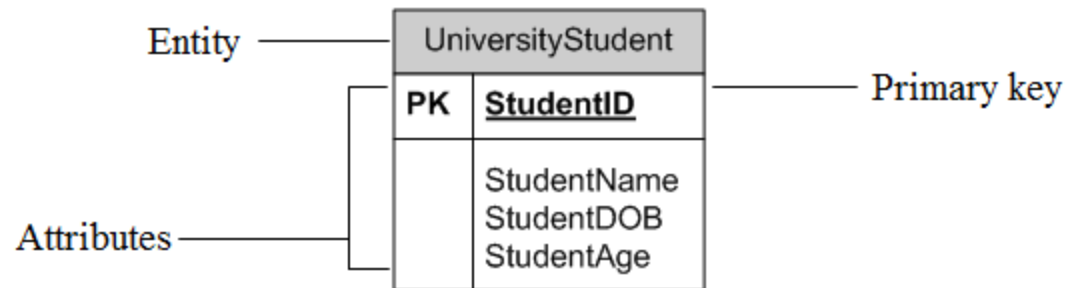
Example:

Given that ...

- “Customer” is an entity.
- “Product” is an entity.
- For a “Customer” we need to know their “customer number” attribute and “name” attribute.
- For a “Product” we need to know the “product name” attribute and “price” attribute.
- “Sale” is an entity that is used to record the interaction of “Customer” and “Product”.

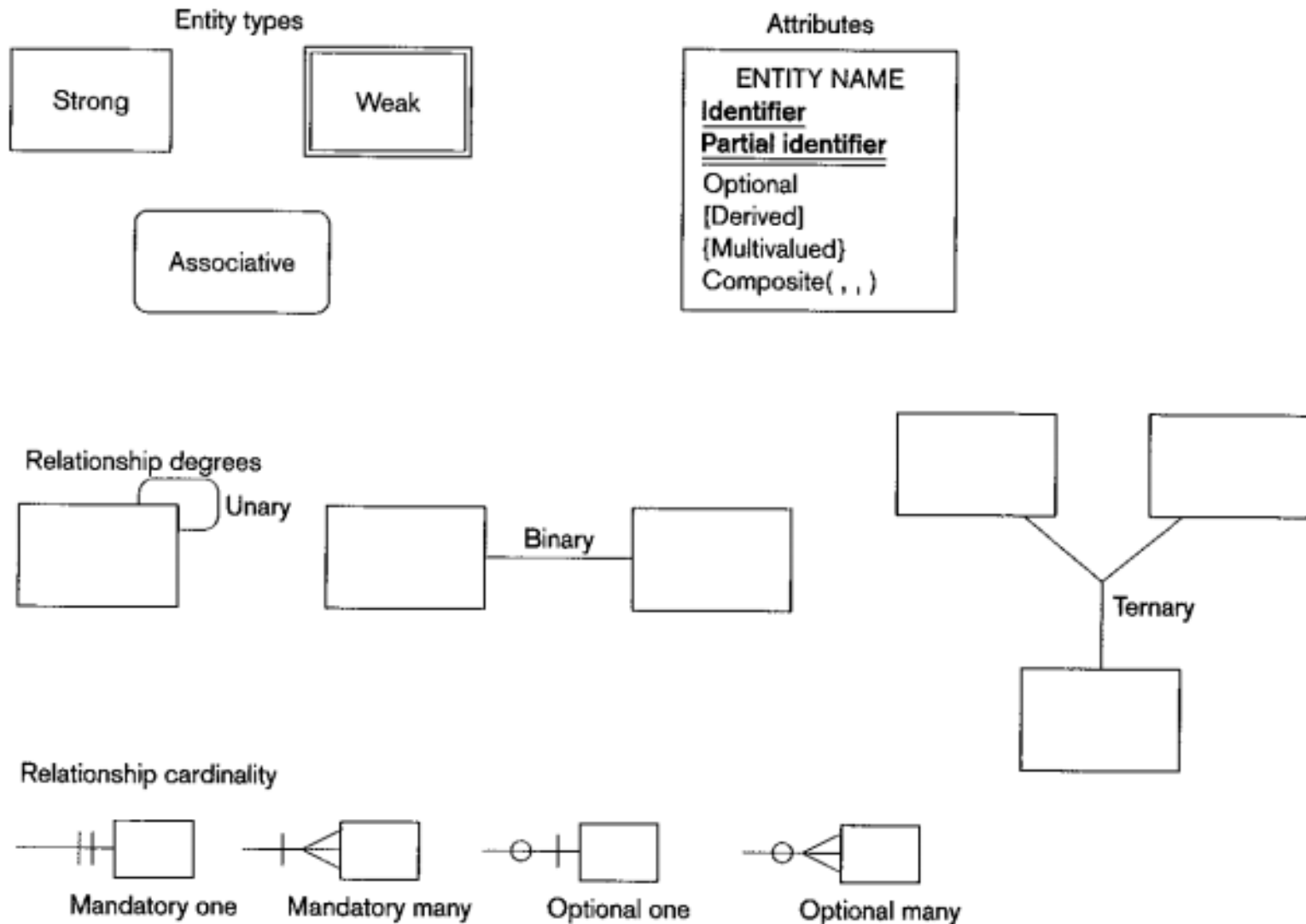
E-R model (Basic Concepts)

- Entity relationship model is considered as a mostly used Data model.
- Entity Relationship Diagrams (ERD) as this is the most widely used
- ERDs have an advantage in that they are capable of being normalized



- Represent entities as rectangles
- List attributes within the rectangle

E-R Components



Attributes & Their Types

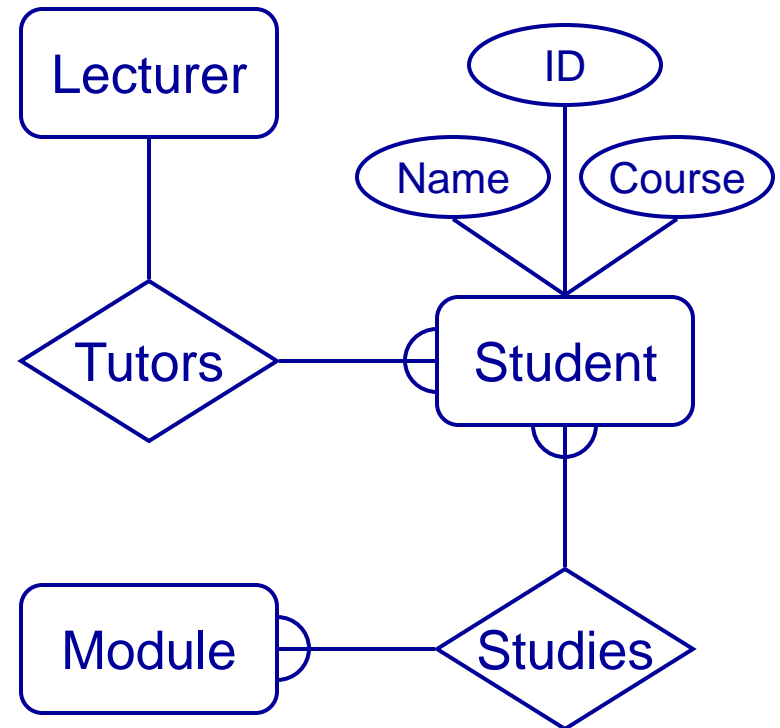
- Entities are represented by means of their properties, called **attributes**. All attributes have values. For example, a student entity may have name, class, and age as attributes.
- **Simple or Atomic Attributes:** This is a type of attributes which can't be divided further. For example Age is a simple attribute.
- **Composite Attributes:** These are the types of attributes which can be divided further. Such as name of a person. Which can be divided into first name, last name, middle name.
- **Single valued attributes:** Those attributes which have single value for an entity such as age, Social security number.
- **Multivalued attributes:** Multivalued attributes can have multiple values. For instance a person may have multiple phone numbers, multiple degrees etc. Multivalued attributes are shown by a double line connecting to the entity in the ER diagram.
- **Stored and Derived attributes:** Attributes whose values are derived from other related attributes or entities. Such as student age is derived by subtracting today date from his DOB. Hence student age is Derived attribute and DOB is stored attribute.

Entity/Relationship Modelling

- E/R Modelling is used for conceptual design
 - Entities - objects or items of interest
 - Attributes - facts about, or properties of, an entity
 - Relationships - links between entities
- Example
 - In a University database we might have entities for Students, Modules and Lecturers. Students might have attributes such as their ID, Name, and Course, and could have relationships with Modules (enrolment) and Lecturers (tutor/tutee)

Entity/Relationship Diagrams

- E/R Models are often represented as E/R diagrams that
 - Give a conceptual view of the database
 - Are independent of the choice of DBMS
 - Can identify some problems in a design

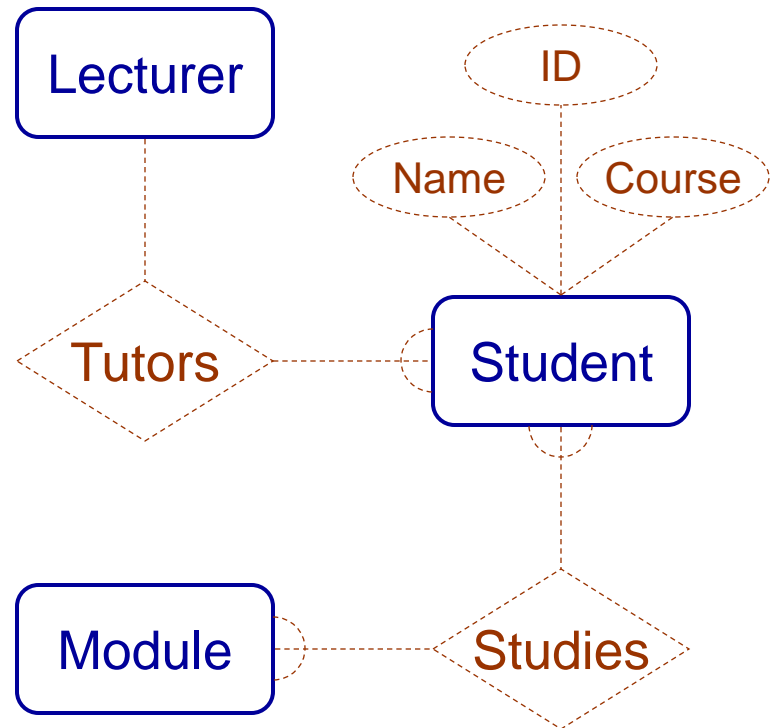


Entities

- Entities represent objects or things of interest
 - Physical things like students, lecturers, employees, products
 - More abstract things like modules, orders, courses, projects
- Entities have
 - A general type or class, such as Lecturer or Module
 - Instances of that particular type, such as Steve Mills, Natasha Alechina are instances of Lecturer
 - Attributes (such as name, email address)

Diagramming Entities

- In an E/R Diagram, an entity is usually drawn as a box with rounded corners
- The box is labelled with the name of the class of objects represented by that entity

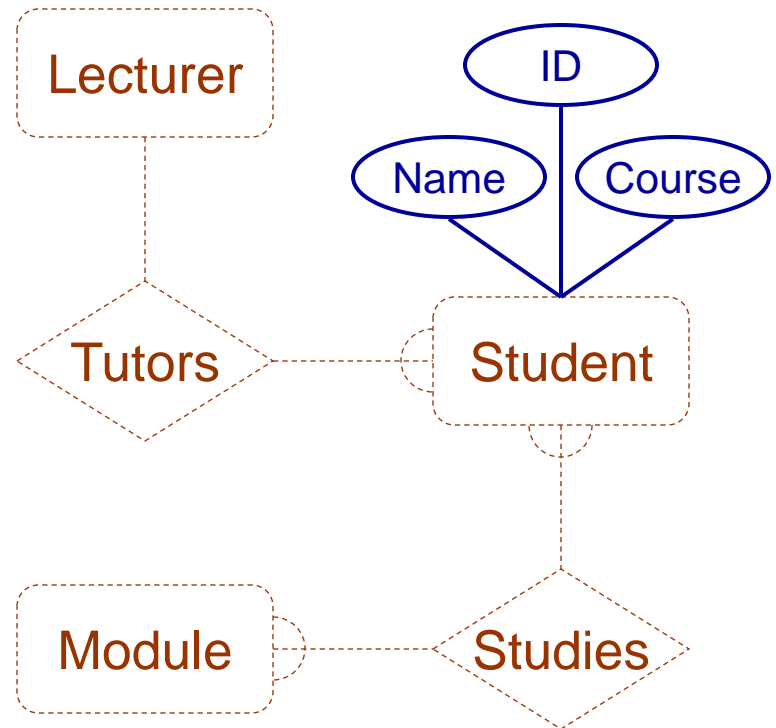


Attributes

- Attributes are facts, aspects, properties, or details about an entity
 - Students have IDs, names, courses, addresses, ...
 - Modules have codes, titles, credit weights, levels, ...
- Attributes have
 - A name
 - An associated entity
 - Domains of possible values
 - Values from the domain for each instance of the entity they are belong to

Diagramming Attributes

- In an E/R Diagram attributes may be drawn as ovals
- Each attribute is linked to its entity by a line
- The name of the attribute is written in the oval



Relationships

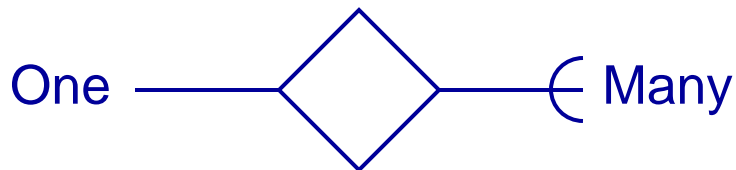
- Relationships are an association between two or more entities
 - Each Student takes several Modules
 - Each Module is taught by a Lecturer
 - Each Employee works for a single Department
- Relationships have
 - A name
 - A set of entities that participate in them
 - A degree - the number of entities that participate (most have degree 2)
 - A cardinality ratio

Cardinality Ratios

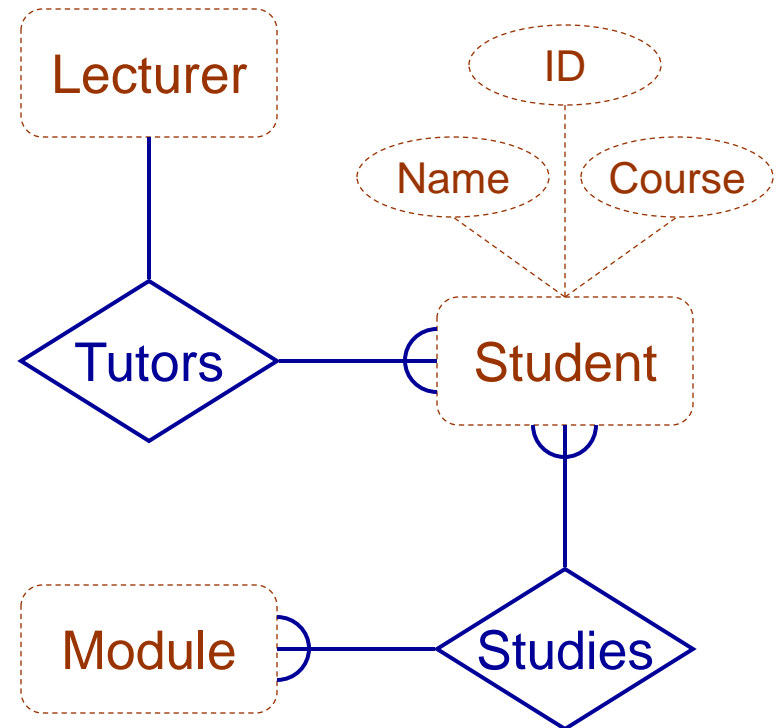
- Each entity in a relationship can participate in zero, one, or more than one instances of that relationship
- This leads to 3 types of relationship...
- One to one (1:1)
 - Each lecturer has a unique office
- One to many (1:M)
 - A lecturer may tutor many students, but each student has just one tutor
- Many to many (M:M)
 - Each student takes several modules, and each module is taken by several students

Diagramming Relationships

- Relationships are links between two entities
- The name is given in a diamond box
- The ends of the link show cardinality

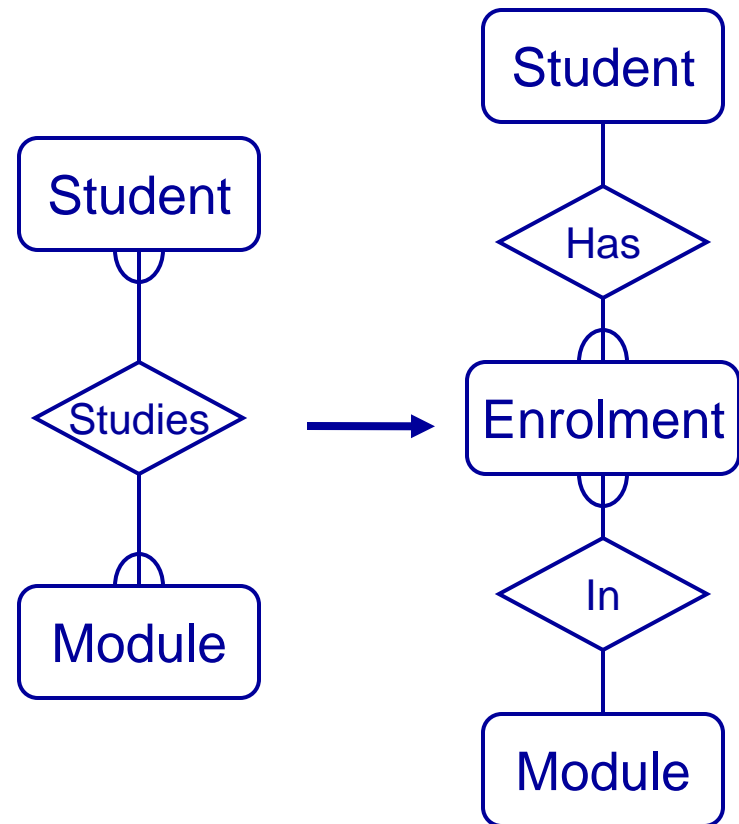


Entity Relationship Modelling



Removing M:M Relationships

- Many to many relationships are difficult to represent
- We can split a many to many relationship into two one to many relationships
- An entity represents the M:M relationship



Making E/R Models

- To make an E/R model you need to identify
 - Entities
 - Attributes
 - Relationships
 - Cardinality ratios
- from a description
- General guidelines
 - Since entities are things or objects they are often nouns in the description
 - Attributes are facts or properties, and so are often nouns also
 - Verbs often describe relationships between entities

Example

A university consists of a number of departments. Each department offers several courses. A number of modules make up each course. Students enrol in a particular course and take modules towards the completion of that course. Each module is taught by a lecturer from the appropriate department, and each lecturer tutors a group of students

Example - Entities

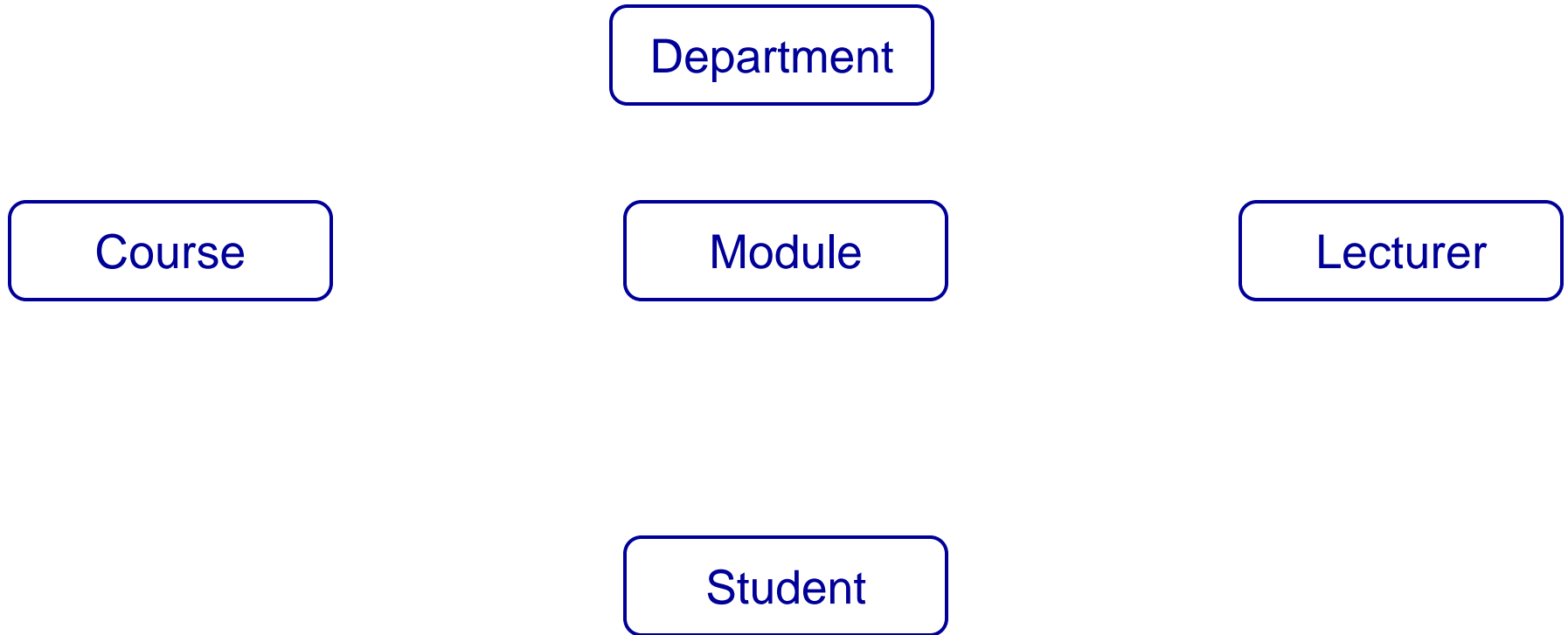
A university consists of a number of **departments**. Each department offers several **courses**. A number of **modules** make up each course. **Students** enrol in a particular course and take modules towards the completion of that course. Each module is taught by a **lecturer** from the appropriate department, and each lecturer tutors a group of students

Example - Relationships

- A university consists of a number of departments. Each department **offers** several courses. A number of modules **make up** each course. Students **enrol in** a particular course and **take** modules towards the completion of that course. Each module is **taught by** a lecturer **from the** appropriate department, and each lecturer **tutors** a group of students

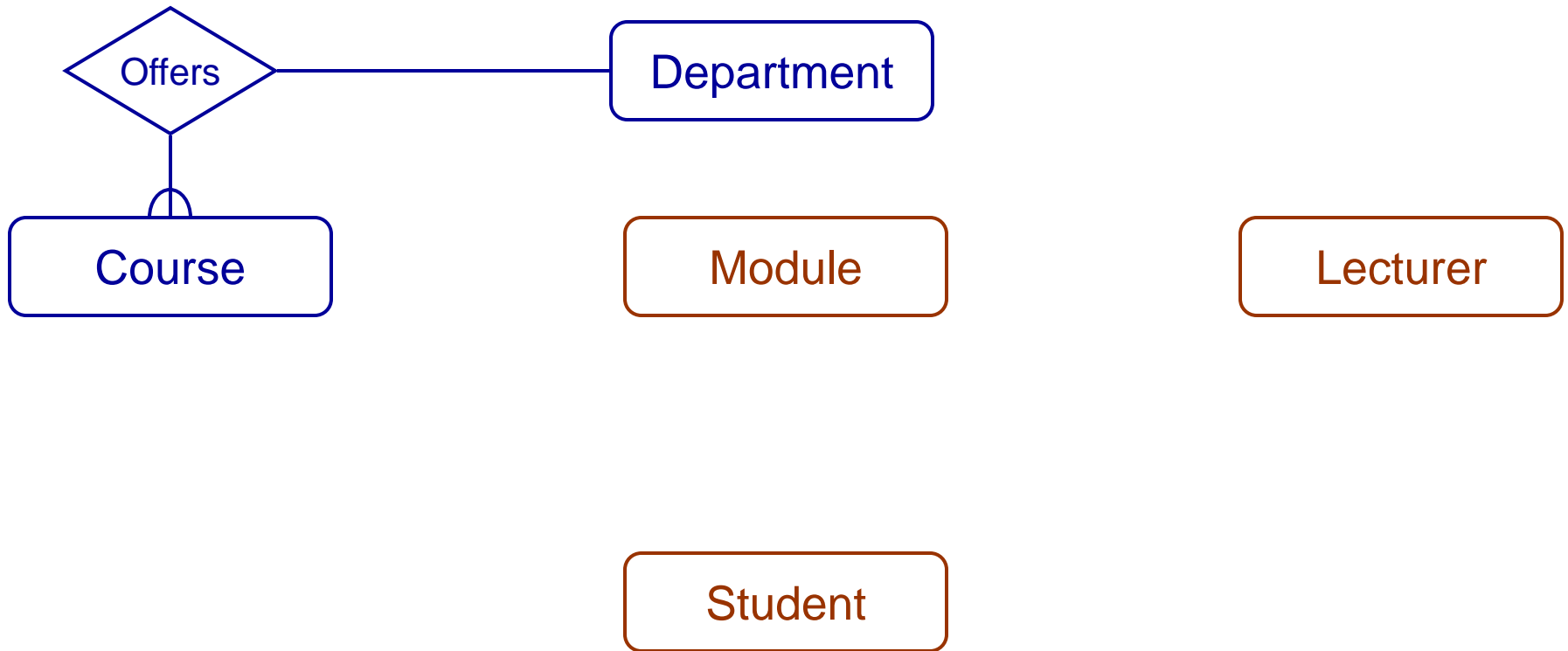
Example - E/R Diagram

Entities: Department, Course, Module, Lecturer, Student



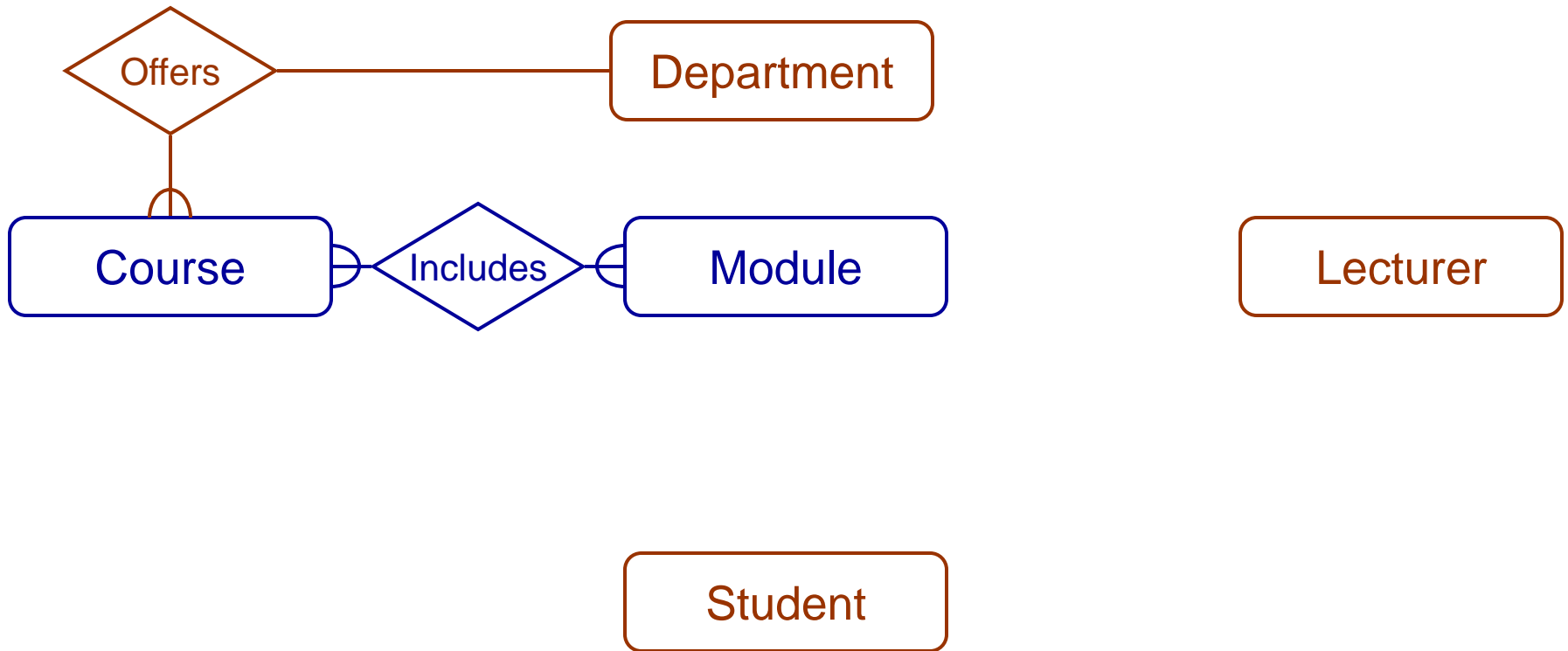
Example - E/R Diagram

Each department offers several courses



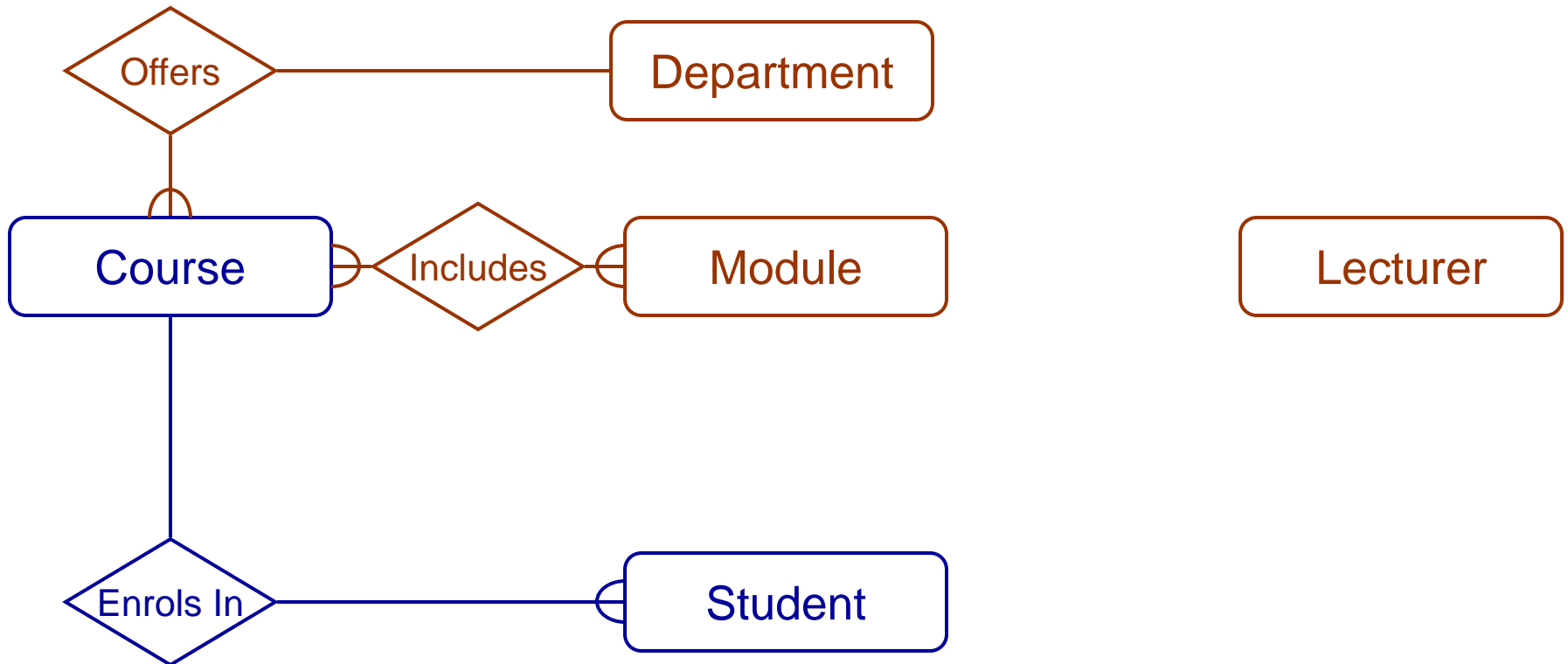
Example - E/R Diagram

A number of modules **make up** each courses



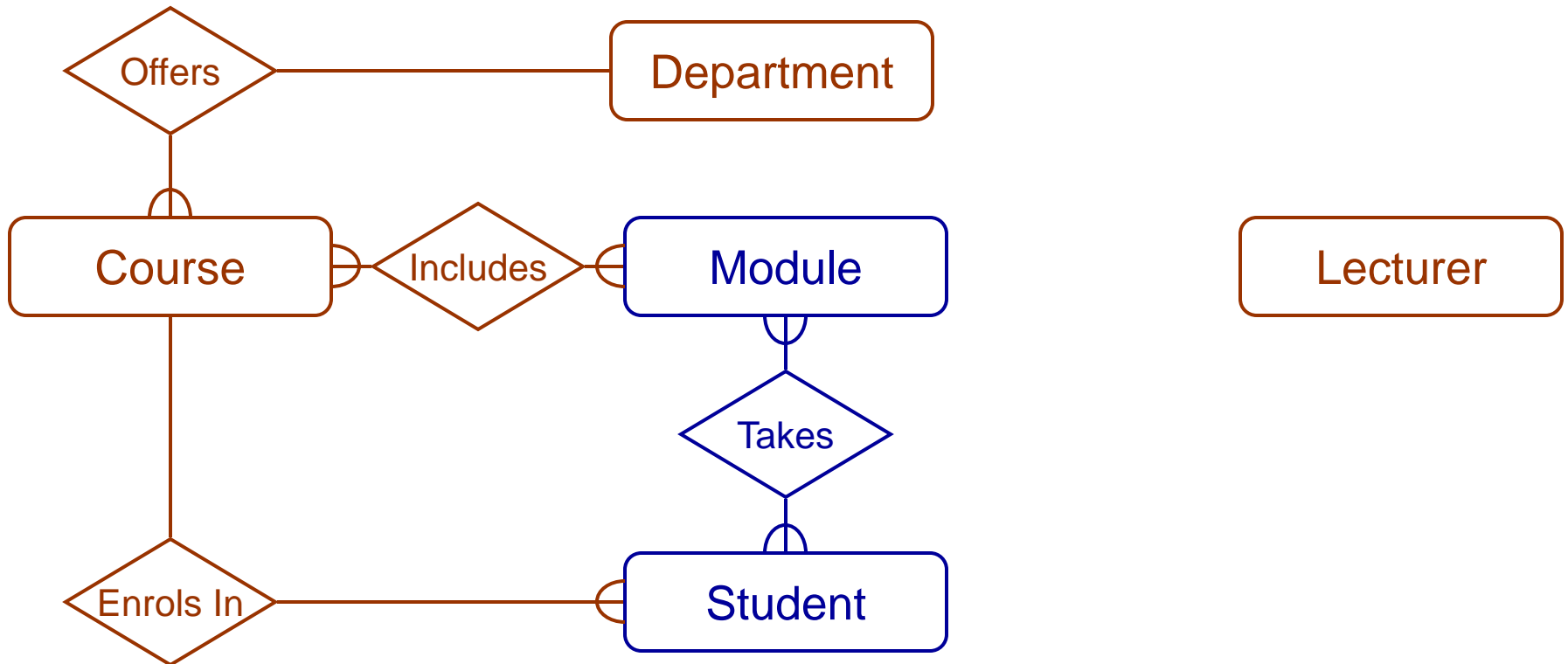
Example - E/R Diagram

Students **enrol** in a particular course



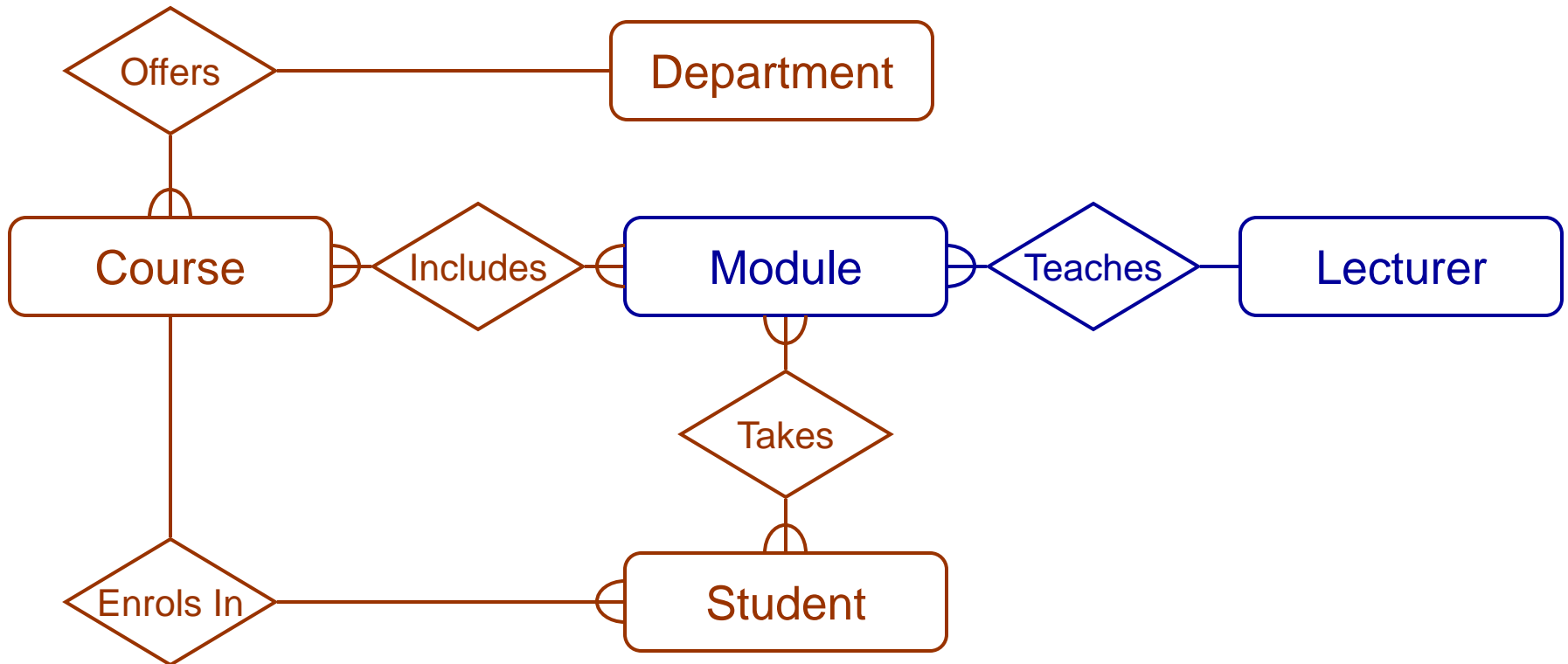
Example - E/R Diagram

Students ... **take** modules



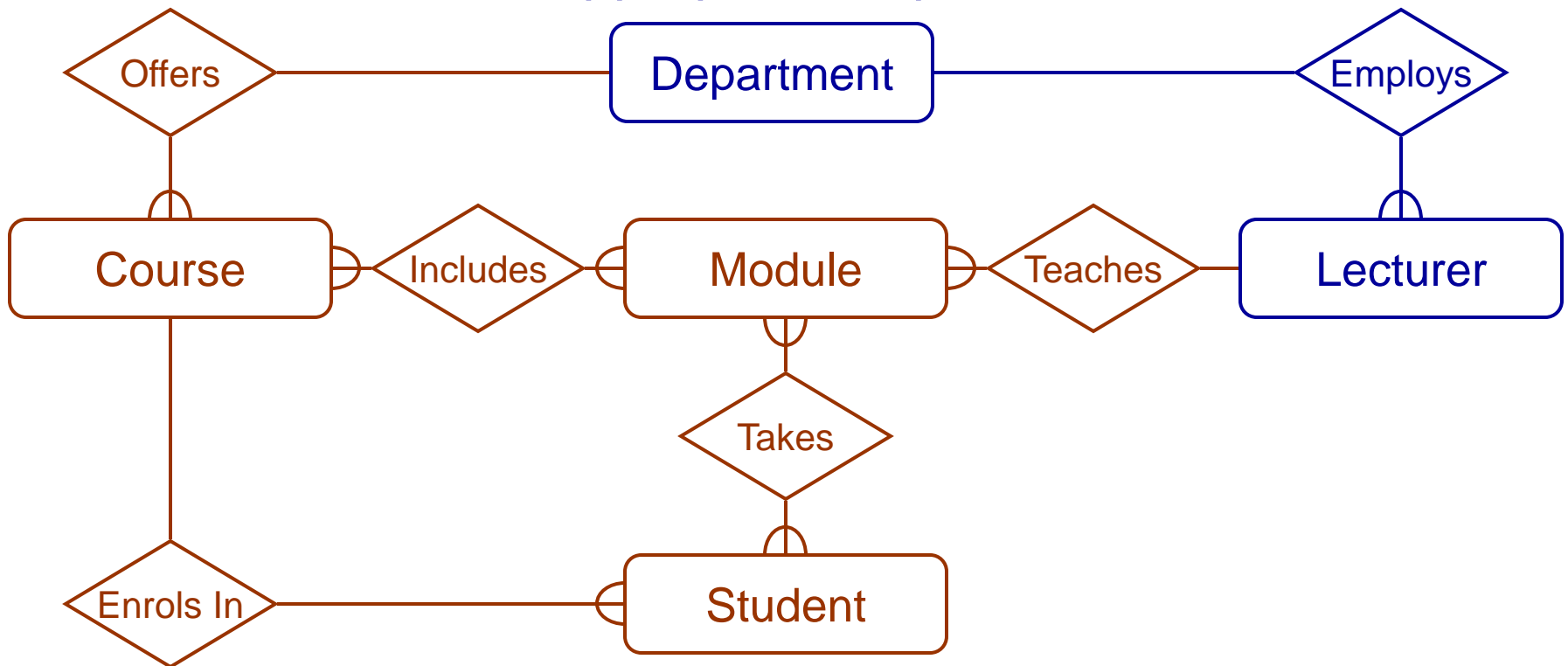
Example - E/R Diagram

Each module is taught by a lecturer



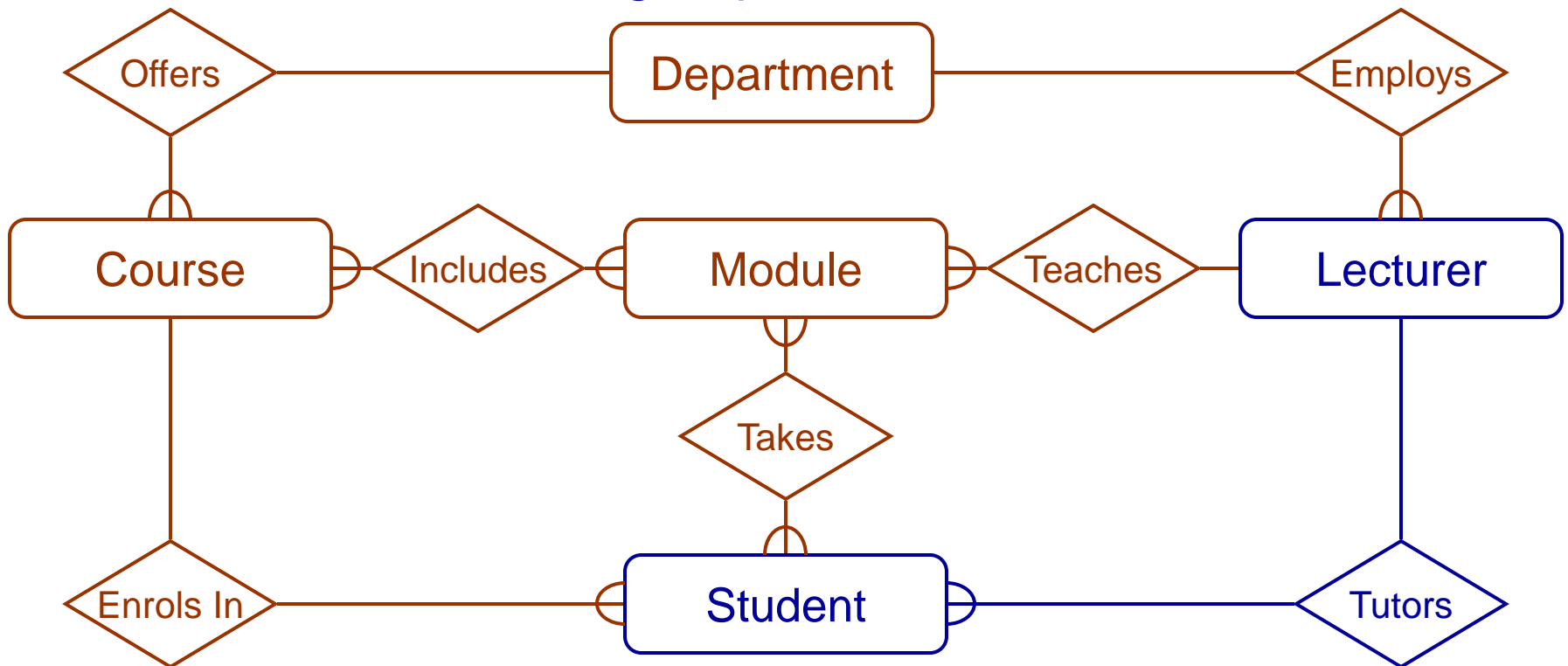
Example - E/R Diagram

a lecturer from the appropriate department

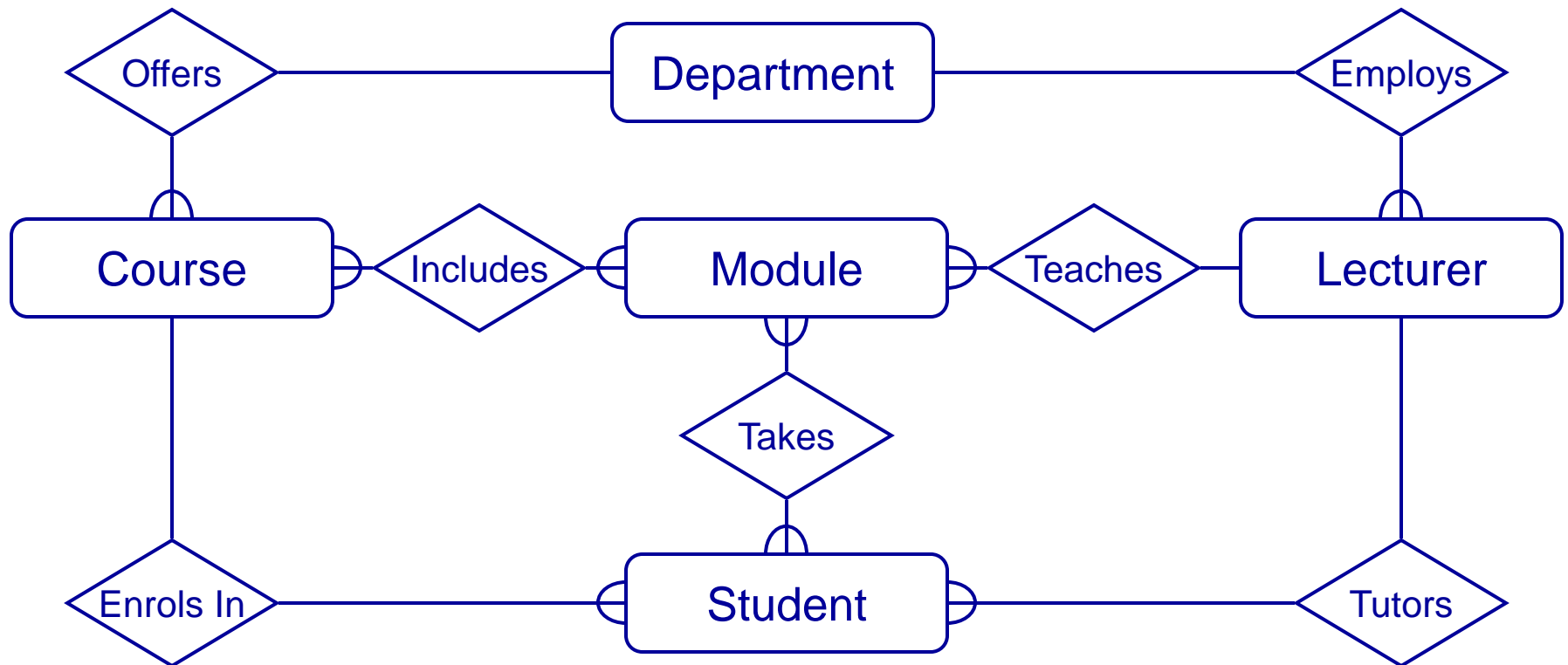


Example - E/R Diagram

each lecturer **tutors** a group of students



Example - E/R Diagram



Entities and Attributes

- Sometimes it is hard to tell if something should be an entity or an attribute
 - They both represent objects or facts about the world
 - They are both often represented by nouns in descriptions
- General guidelines
 - Entities can have attributes but attributes have no smaller parts
 - Entities can have relationships between them, but an attribute belongs to a single entity

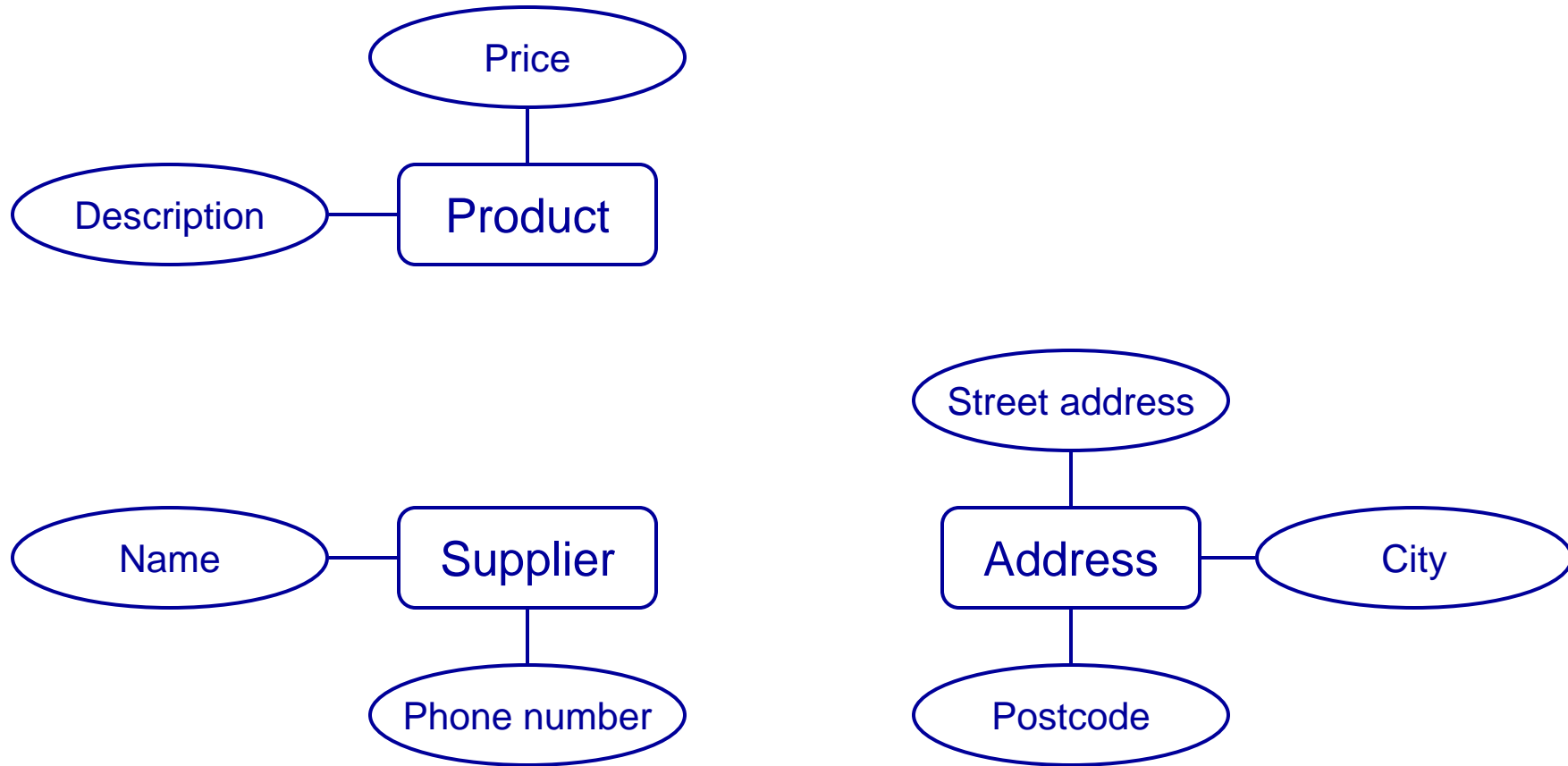
Example

We want to represent information about products in a database. Each product has a description, a price and a supplier. Suppliers have addresses, phone numbers, and names. Each address is made up of a street address, a city, and a postcode.

Example - Entities/Attributes

- Entities or attributes:
 - product
 - description
 - price
 - supplier
 - address
 - phone number
 - name
 - street address
 - city
 - postcode
- Products, suppliers, and addresses all have smaller parts so we can make them entities
- The others have no smaller parts and belong to a single entity

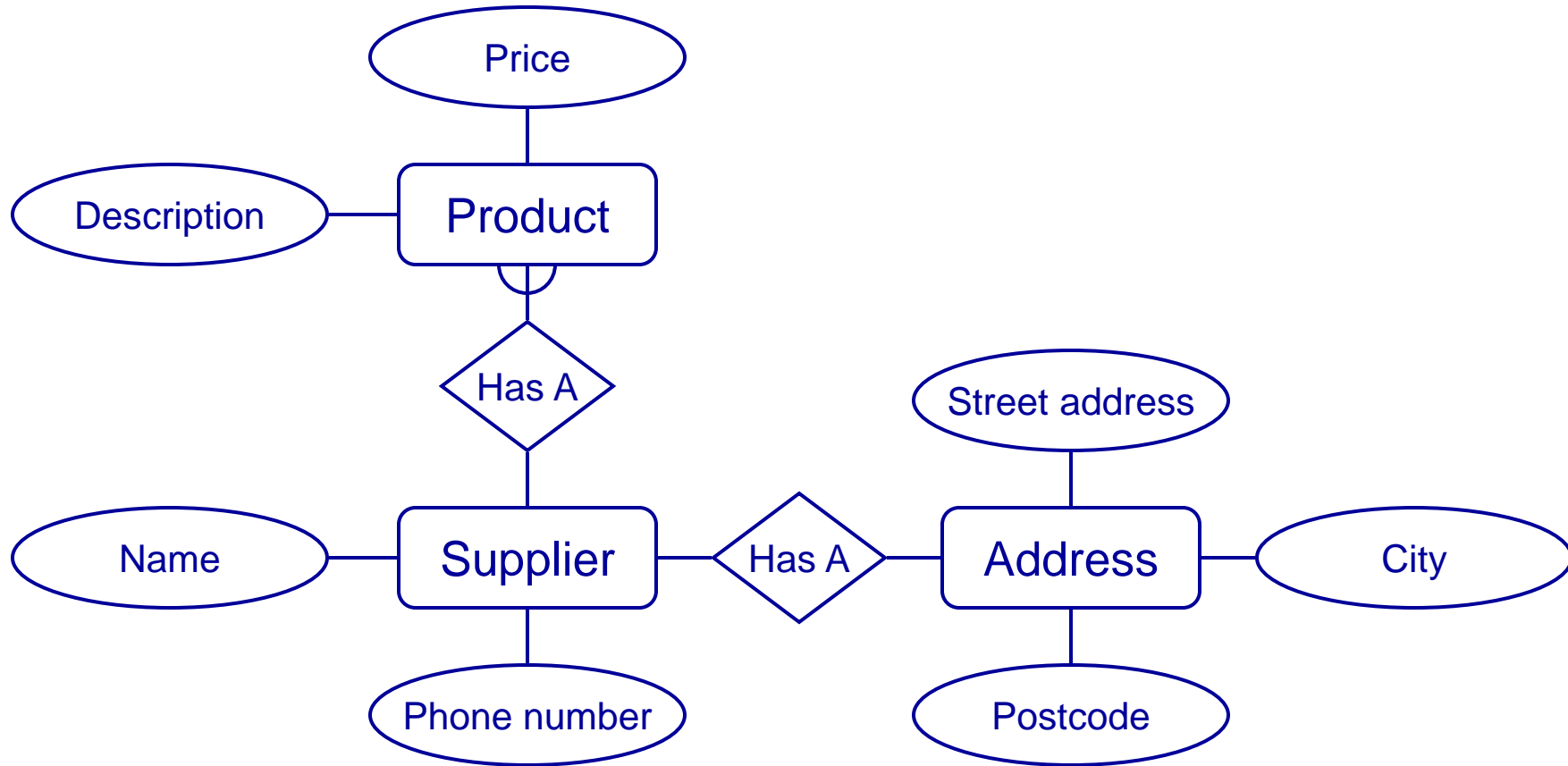
Example - E/R Diagram



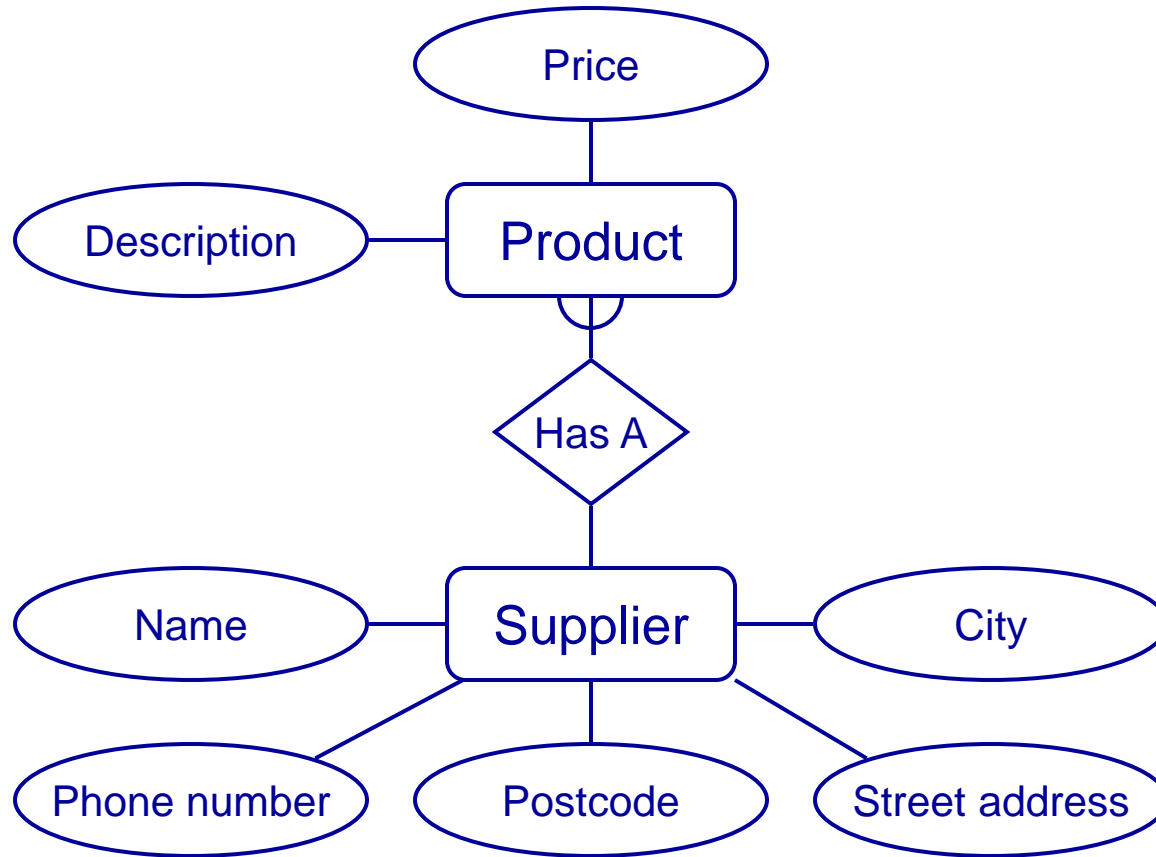
Example - Relationships

- Each product has a supplier
 - Each product has a single supplier but there is nothing to stop a supplier supplying many products
 - A many to one relationship
- Each supplier has an address
 - A supplier has a single address
 - It does not seem sensible for two different suppliers to have the same address
 - A one to one relationship

Example - E/R Diagram



Example - E/R Diagram



Making E/R Diagrams

- From a description of the requirements identify the
 - Entities
 - Attributes
 - Relationships
 - Cardinality ratios of the relationships
- Draw the E/R diagram and then
 - Look at one to one relationships as they might be redundant
 - Look at many to many relationships as they might need to be split into two one to many links

"A database will be made to store information about patients in a hospital. On arrival, each patient's personal details (name, address, and telephone number) are recorded where possible, and they are given an admission number. They are then assigned to a particular ward (Accident and Emergency, Cardiology, Oncology, etc.). In each ward there are a number of doctors and nurses. A patient will be treated by one doctor and several nurses over the course of their stay, and each doctor and nurse may be involved with several patients at any given time."

Classification of entities

- Entities types are classified into two types.
 - Weak Entity Types
 - Strong Entity Types
-
- These types will be discussed after Keys Lecture

So far.....!!!!

Identify the *entities, attributes, relationships, and cardinality ratios* from the description.

Draw an entity-relationship diagram showing the items you identified.

Many-to-many relationships are hard to represent in SQL tables. Explain why many-to-many relationships cause problems in SQL tables, and show how these problems may be overcome.