

## 8.2 Describes the main components of the relational database model

Time: 4 periods

**Defines relations / tables**

### Relational Data Model

Table name: STUDENT

STU_NUM	STU_LNAME	STU_FNAME	STU_INIT	STU_DOB	STU_HRS	STU_CLASS
321452	Bowser	William	C	12-Feb-1975	42	So
324257	Smithson	Anne	K	15-Nov-1981	81	Jr
324258	Brewer	Juliette		23-Aug-1969	36	So
324269	Oblonski	Walter	H	16-Sep-1976	66	Jr
324273	Smith	John	D	30-Dec-1958	102	Sr
324274	Katinga	Raphael	P	21-Oct-1979	114	Sr
324291	Robertson	Gerald	T	08-Apr-1973	120	Sr
324299	Smith	John	B	30-Nov-1986	15	Fr

STUDENT table, continued

STU_GPA	STU_TRANSFER	DEPT_CODE	STU_PHONE	PROF_NUM
2.84	No	BIOL	2134	205
3.27	Yes	CIS	2256	222
2.26	Yes	ACCT	2256	228
3.09	No	CIS	2114	222
2.11	Yes	ENGL	2231	199
3.15	No	ACCT	2267	228
3.87	No	EDU	2267	311
2.92	No	ACCT	2315	230

STU_HRS	= Credit hours earned	STU_GPA	= Grade point average
STU_CLASS	= Student classification	STU_PHONE	= 4-digit campus phone extension
STU_DOB	= Student date of birth	PROF_NUM	= Number of the professor who is the student's advisor

### A Logical View of Data

- Relational model enables us to view data logically (no implementation details) rather than physically (implementation details)
- Relational models are easier to understand

### Table

- A table is also called **a relation or an entity set**
- Resembles a row and column file conceptually

## Characteristics of Tables

A table contains data about a **group of related entities** e.g., a group of students

- **Table:** entity set, a two-dimensional structure composed of rows and columns
- **Each table row (tuple)** represents a single entity occurrence with the entity set.
  - An entity/object (e.g., a student)
- **Each table Column** represents an attribute and each column has a distinct name (e.g., student ID)
- The intersection of a row and column represents a **single data value**
- All values in a column must conform to the **same data type/format**
- Each column has a range of value called the **attribute domain**
- From the DBMS view point, **rows and columns can be in any order**
- Each table must have a key, one or more attributes that **uniquely identifies each row**

## DBMS Keys

A DBMS key is an attribute or set of an attribute which helps you to identify a row (tuple) in a relation (table). They allow you to find the relation between two tables. Keys help you uniquely identify a row in a table by a combination of one or more columns in that table.

Example:

Employee ID	FirstName	LastName
11	Andrew	Johnson
22	Tom	Wood
33	Alex	Hale

In the above-given example, **employee ID is a primary key** because it uniquely identifies an employee record. In this table, no other employee can have the same employee ID.

## Keys in short

- Each row in a table must be uniquely identifiable
- Key:** one or more attributes whose values can uniquely identify each row

## How to identify a key?

- Based on determination, can identify a key.
- If you know the value of attribute A, you can look up (determine) the value of attribute B,
- i.e., A determines B or  $A \rightarrow B$

### Example

STU\_NUM  $\rightarrow$  STU\_LNAME, STU\_FNAME, STU\_DOB

If an attribute determines all other attributes, that attribute is a key.

- If a combination of attributes determines all other attributes, that combination is a key.

### Examples:

- STU\_NUM
- STU\_FNAME + STU\_DOB + STU\_PHONE

## Key attribute

- Any attribute that is part of a key
- e.g. STU\_NUM, STU\_DOB,

## Composite key

A key which has multiple attributes to uniquely identify rows in a table is called a composite key. The difference between compound and the composite key is that any part of the compound key can be a foreign key, but the composite key may or maybe not a part of the foreign key.

StudentId	StudentName	Year	Semester
0023765	John Doe	2009	2
0035643	Ann Smith	2009	2
0061234	Pete Smith	2009	2

StudentId	UnitCode	UnitName
0023765	UG45783	Advance Database
0023765	UG45832	Network Systems
0023765	UG45734	Multi-User Operating Systems
0035643	UG45832	Network Systems
0035643	UG45951	Project
0061234	UG45783	Advance Database

Composite Key

**Candidate key**

A super key with no repeated attribute is called candidate key.

The Primary key should be selected from the candidate keys. Every table must have at least a single candidate key.

**Properties of Candidate key:**

- It must contain unique values
- Candidate key may have multiple attributes
- Must not contain null values
- It should contain minimum fields to ensure uniqueness
- Uniquely identify each record in a table

Example: In the given table Stud ID, Roll No, and email are candidate keys which help us to uniquely identify the student record in the table.

StudID	Roll No	First Name	LastName	Email
1	11	Tom	Price	<a href="mailto:abc@gmail.com">abc@gmail.com</a>
2	12	Nick	Wright	<a href="mailto:xyz@gmail.com">xyz@gmail.com</a>
3	13	Dana	Natan	<a href="mailto:mno@yahoo.com">mno@yahoo.com</a>

**Primary Key (PK)**

A column or group of columns in a table which helps us to uniquely identify every row in that table is called a primary key. This DBMS can't be a duplicate. The same value can't appear more than once in the table.

**Rules for defining Primary key:**

- Two rows can't have the same primary key value
- It must for every row to have a primary key value.
- The primary key field cannot be null.
- The value in a primary key column can never be modified or updated if any foreign key refers to that primary key.
- One of the candidate keys and chosen to be the unique row identifier
- Please note that **each table must have a Primary Key**

Example:

In the following example, StudID is a Primary Key.

StudID	Roll No	First Name	LastName	Email
1	11	Tom	Price	<a href="mailto:abc@gmail.com">abc@gmail.com</a>
2	12	Nick	Wright	<a href="mailto:xyz@gmail.com">xyz@gmail.com</a>
3	13	Dana	Natan	<a href="mailto:mno@yahoo.com">mno@yahoo.com</a>

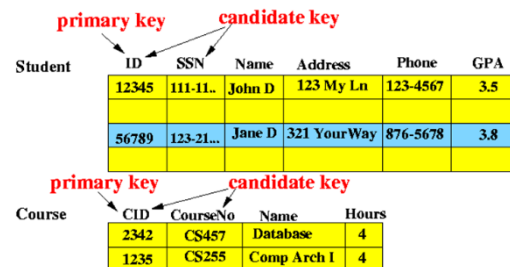
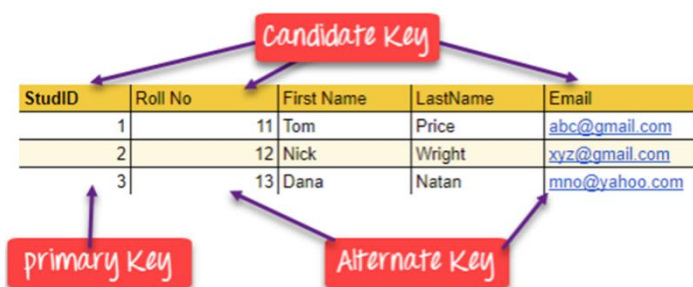
**Alternate Key**

All the keys which are not primary key are called an alternate key. It is a candidate key which is currently not the primary key. However, A table may have single or multiple choices for the primary key.

Example: In this table.

StudID, Roll No, Email are qualified to become a primary key. But since StudID is the primary key, Roll No, Email becomes the alternative key.

StudID	Roll No	First Name	LastName	Email
1	11	Tom	Price	<a href="mailto:abc@gmail.com">abc@gmail.com</a>
2	12	Nick	Wright	<a href="mailto:xyz@gmail.com">xyz@gmail.com</a>
3	13	Dana	Natan	<a href="mailto:mno@yahoo.com">mno@yahoo.com</a>



## Null Values

- No data entry
  - Not permitted in primary key
  - Should be avoided in other attributes
- Can represent
  - An unknown attribute value
  - A known, but missing, attribute value
  - A “not applicable” condition
- Can create problems in function usage and table linkage

## Linking tables together

Table name: PRODUCT  
Primary key: PROD\_CODE  
Foreign key: VEND\_CODE

PROD_CODE	PROD_DESCRIPTION	PROD_PRICE	PROD_ON_HAND	VEND_CODE
001278-AB	Claw hammer	12.95	23	232
123-21UUY	Housetite chain saw, 16-in. bar	189.99	4	235
QER-34256	Sledge hammer, 16-lb. head	18.63	6	231
SRE-657UG	Rat-tail file	2.99	15	232
ZZX/3245Q	Steel tape, 12-ft. length	6.79	8	235

Controlled redundancy

link

Table name: VENDOR  
Primary key: VEND\_CODE  
Foreign key: none

VEND_CODE	VEND_CONTACT	VEND_AREACODE	VEND_PHONE
230	Shelly K. Smithson	608	555-1234
231	James Johnson	615	123-4536
232	Annelise Crystall	608	224-2134
233	Candice Wallace	904	342-6567
234	Arthur Jones	615	123-3324
235	Henry Ortozo	615	899-3425

## Controlled Redundancy

- **Redundancy** is unnecessary duplication of data
- **Controlled redundancy** makes a relational database work
- Tables that share common attributes enable us to **link tables** together
- Multiple occurrences of such values are **not redundant as they're essential in creating the link/relationship**

## Foreign key (FK)

A foreign key is a column which is added to create a relationship with another table. Foreign keys help us to maintain data integrity and also allow navigation between two different instances of an entity. Every relationship in the model needs to be supported by a foreign key.

Example:

DeptCode	DeptName
001	Science
002	English
005	Computer

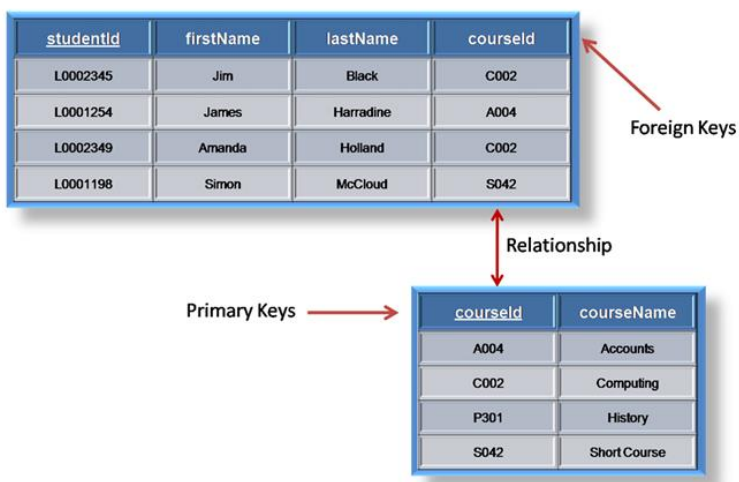
In this example, we have two table, teacher and department in a school. However, there is no way to see which teacher works in which department.

In this table, adding the foreign key in Deptcode to the Teacher table, we can create a relationship between the two tables.

This concept is also known as Referential Integrity.

Teacher ID	DeptCode	Fname	Lname
B002	002	David	Warner
B017	002	Sara	Joseph
B009	001	Mike	Brunton

Teacher ID	Fname	Lname
B002	David	Warner
B017	Sara	Joseph
B009	Mike	Brunton





## Referential integrity

- FK contains a value that refers to an existing valid row in another table or it can contain null

## Secondary key

- Key used strictly for data retrieval purposes, narrowing down a search

Table name: PRODUCT  
Primary key: PROD\_CODE  
Foreign key: VEND\_CODE

PROD_CODE	PROD_DESCRIPT	PROD_PRICE	PROD_ON_HAND	VEND_CODE
001278-AB	Claw hammer	12.95	23	232
123-21UUY	Houselite chain saw, 16-in. bar	189.99	4	235
QER-34256	Sledge hammer, 16-lb. head	18.63	6	231
SRE-657UG	Rat-tail file	2.99	15	232
ZZX/3245Q	Steel tape, 12-ft. length	6.79	8	235

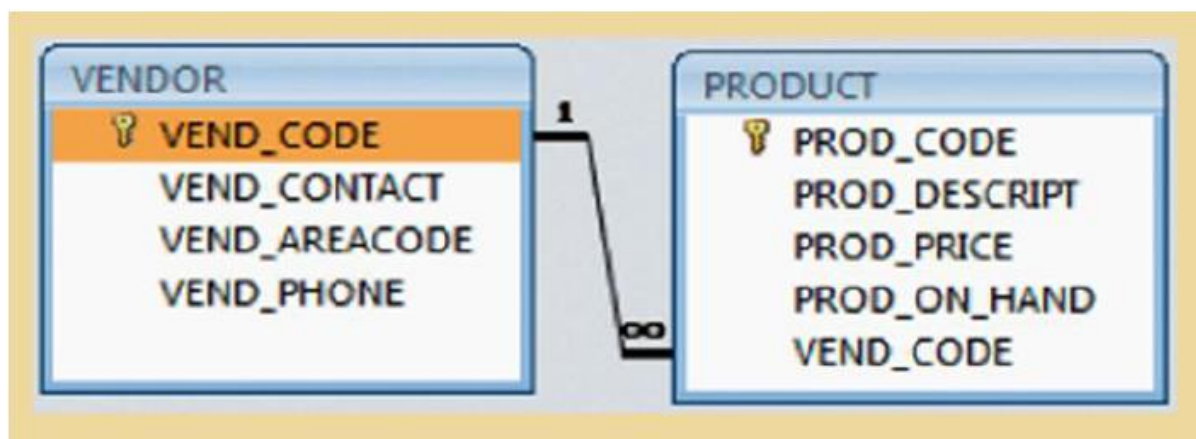
Foreign Key

Primary Key

link

Table name: VENDOR  
Primary key: VEND\_CODE  
Foreign key: none

VEND_CODE	VEND_CONTACT	VEND_AREACODE	VEND_PHONE
230	Shelly K. Smithson	608	555-1234
231	James Johnson	615	123-4536
232	Annelise Crystall	608	224-2134
233	Candice Wallace	904	342-6567
234	Arthur Jones	615	123-3324
235	Henry Ortozo	615	899-3425



### Difference between Primary key & foreign key

Primary Key	Foreign Key
Helps you to uniquely identify a record in the table.	It is a field in the table that is the primary key of another table.
Primary Key never accept null values.	A foreign key may accept multiple null values.
Primary key is a clustered index and data in the DBMS table are physically organized in the sequence of the clustered index.	A foreign key cannot automatically create an index, clustered or non-clustered. However, you can manually create an index on the foreign key.
You can have the single Primary key in a table.	You can have multiple foreign keys in a table.

Key Type	Description
Super key	An attribute (or combination of attributes) that uniquely identifies each row in a table.
Candidate Key	A minimal (irreducible) super key. A super key that does not contain a subset of attributes that is itself a super key.
Primary key	A candidate key selected to uniquely identify all other attribute values in any given row. Cannot contain null entries.
Secondary key	An attribute (or combination of attributes) used strictly for data retrieval purposes.
Foreign key	An attribute (or combination of attributes) in one table whose values must either match the primary key in another table or be null.

## Integrity Rules

### Primary key

- All PK entries are unique.
- No part of a PK may be null.

### Foreign key may have:

- An entry matching a PK value in the related table.
- A null entry.

NOTE: many RDBMSs enforce integrity rules automatically.

Consider the relationship between two tables School and Student (using a foreign key), FK may have NULL values (because a Student is not required to belong to a School)

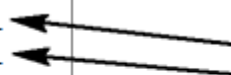
For example:

School

<u>id</u>	name
1	Some School
2	Another School

Student

<u>id</u>	name	school_id
1	Paul	2
2	William	NULL
3	John	NULL
4	Steven	1
5	George	1



**Domain**

A **domain** is defined as the set of all unique values permitted for an attribute. For example, a **domain** of date is the set of all possible valid dates, a **domain** of integer is all possible whole numbers, a **domain** of day-of-week is Monday, Tuesday ... .. This in effect is defining rules for a particular attribute.

## Examples

Attribute	Domain	Valid Data Values
No	Int(5)	0 to 9 numbers
Name	Varchar(20)	A to Z letters

## Reference

[https://www.tutorialspoint.com/dbms/er\\_model\\_basic\\_concepts.htm](https://www.tutorialspoint.com/dbms/er_model_basic_concepts.htm)

<https://www.guru99.com/dbms-keys.html>

[https://www.tutorialspoint.com/dbms/database\\_normalization.htm](https://www.tutorialspoint.com/dbms/database_normalization.htm)