

Tishk International University
Department of Information Technology
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Database Systems I

Lecture 3

Keys, Normalization, Relationships

Wisam Abdulaziz Qadir

Wisam.abdulaziz@tiu.edu.iq

Objectives




- Primary Key
- Foreign Key
- Database Design Process
- Normalization
- Relationships

Primary Key



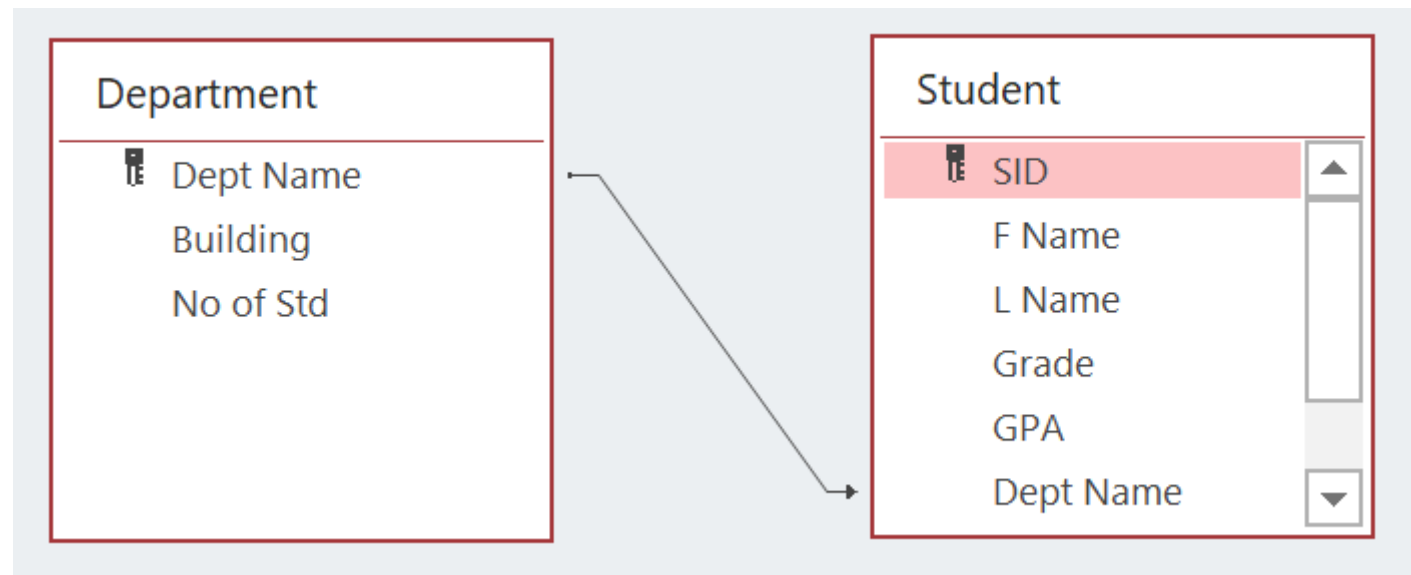
- It is a key in a table that is unique for each record.
- It is a unique identifier.
- **Ex: ID, Passport No., Driver License No., etc.**
- A table in relational database must always have one and only one **primary key**.

Student	
	St_ID
	st_name
	dept_name
	mark

Foreign Key



- It is a field in a table that provides a link between data in two tables.
- It acts as a cross-reference between tables because it references to the **primary key** of another table.
- It is used for creating link between tables.



Unique Values and Primary Keys



- Most of the time there is even not only a piece of naturally unique data.
- So, we will add a field to the table to generate unique values, and that field will be the **Primary key** of that table.

ID	student_name	dept_name	mark
1	Dara	IT	78
2	Zara	Computer Eng.	76
3	Nasrin	Architecture	98
4	Azad	IT	96
5	Hawre	Dentistry	67

Database Design Process



- **Step 1:** Define the Purpose of the Database
- **Step 2:** Find and organize the information required
- **Step 3:** Gather Data (field names), Organize in tables and Specify the Keys
- **Step 4:** Create Relationships among Tables
- **Step 5:** Refine & Normalize the Design

Database Design Process (cont.)



- **Step 1:** Define the Purpose of the Database (Requirement Analysis).
 - This helps prepare for the remaining steps.

Database Design Process (cont.)



- **Step 2:** Find and organize the information required.
 - Divide information items into major groups called tables (such as: Student, Department, etc.).
 - Each group then becomes a table.



ID	student_name	dept_name	mark
1	Dara	IT	78
2	Zara	Computer Eng.	76
3	Nasrin	Architecture	98
4	Azad	IT	96
5	Hawre	Dentistry	67

Student table


dept_name	building	no_of_students
IT	Main Building	80
Computer Eng.	Main Building	60
Architecture	Main Building	85
Dentistry	Dentistry Building	110
Mathematics	Education Building	40

Department table

Database Design Process (cont.)



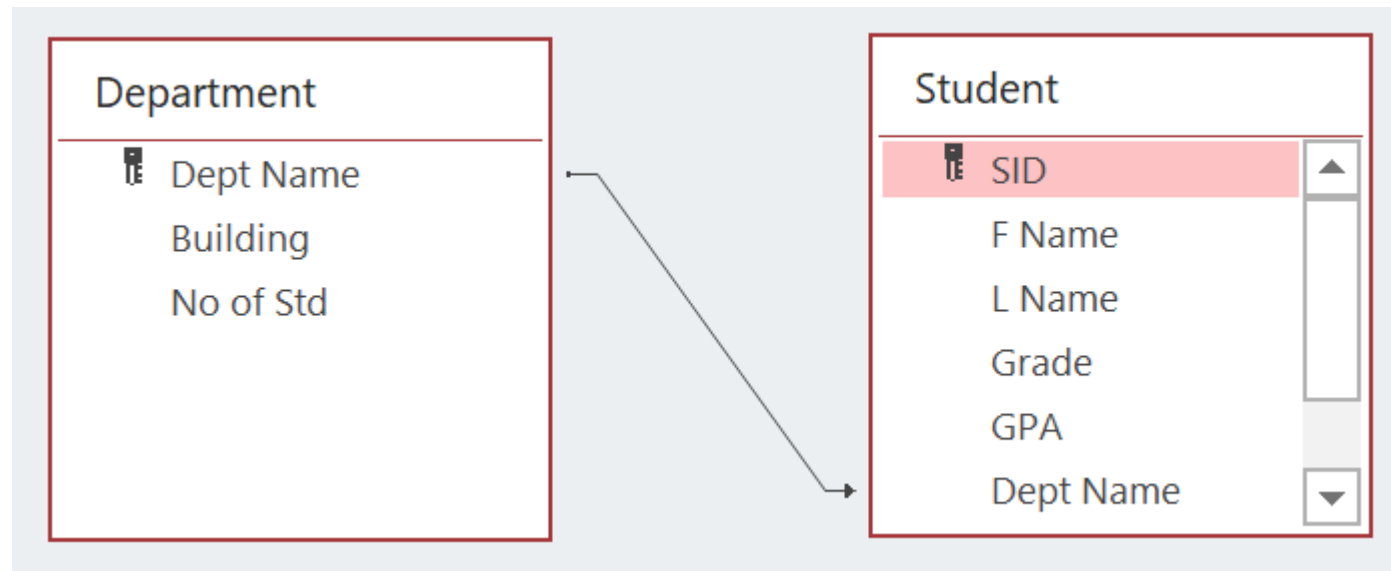
- **Step 3:** Gather Data, Organize in tables and Specify the Keys.
 - Decide what information (field) need to be stored in each table.
 - Specify each table's primary key.

Student	
	St_ID
	St_Namee
	building
	dept_name
	no_of_students

Database Design Process (cont.)



- **Step 4:** Create Relationships among the tables.
 - Look at each table and decide how the data in one table is related to the data in the other tables.



Database Design Process (cont.)



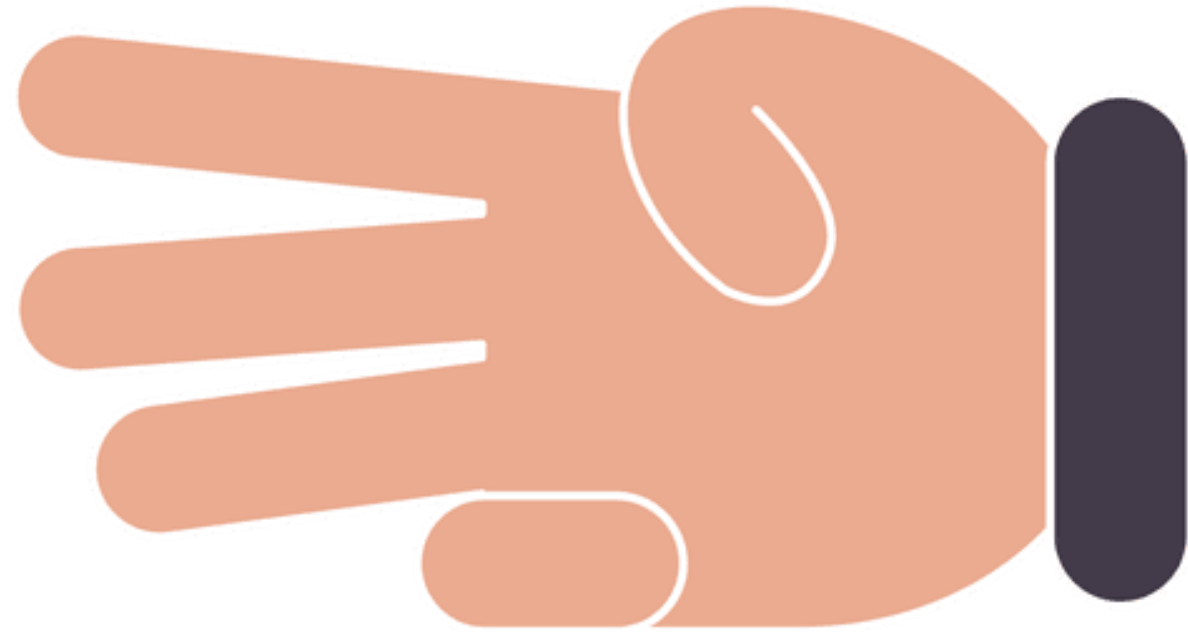
- **Step 5:** Refine and normalize the design.
 - Apply the **Normalization Rules** to check whether your database is structurally correct and optimal.



Normalization



- There are 3 normalization rules called normal forms.
- **First Normal Form (1NF)**
- **Second Normal Form (2NF)**
- **Third Normal Form (3NF)**

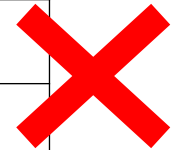


Normalization (cont.)



- **First Normal Form (1NF):** A table is 1NF if every cell contains a single value, not multiple values.
- This property is known as atomic.

full-name
Dara Ahmed
Zara Ali
Serdar Mustafa



first-name
Dara
Zara
Serdar

last-name
Ahmed
Ali
Mustafa

Normalization (cont.)



- **Second Normal Form (2NF):** A table is 2NF, if it is 1NF and every non-key fields are fully dependent on the primary key.

Note: If the primary key is made up of several fields, every non-key field should depend on the entire set and not part of it.

The diagram shows a table with four columns: st_id, st_name, dept_name, and mark. A red horizontal line is drawn under the st_id column header. Three blue curved arrows originate from the st_id column and point to the st_name, dept_name, and mark columns, indicating that st_id is the primary key and these three non-key fields are fully functionally dependent on it.

st_id	st_name	dept_name	mark
1	Ali	IT	80
2	Ahmed	Computer Eng.	92
3	Dara	Architecture	85
4	Zara	Dentistry	97

Normalization (cont.)



- **Third Normal Form (3NF)**: A table is 3NF, if it is 2NF and the non-key fields are independent of each others.

The diagram shows two green curved arrows pointing from the 'st_name' column to the 'dept_name' column. Each arrow is crossed out with a large red 'X', indicating that the relationship between these two non-key fields is not independent, thus failing the 3NF requirement.

st_id	st_name	dept_name	mark
1	Dara	IT	80
2	Ahmed	Computer Eng.	92
3	Dara	Architecture	85
4	Zara	Dentistry	97

Normalization Example 1



SID	Full Name	Grade	GPA	Faculty	Department	Building	No of Std
1	Dara Ahmed	3	3.5	Science	IT	Main	350
2	Zara Nadim	2	4	Engineering	Architecture	Main	400
3	Nawzad Ali	4	3.5	Dentistry	Dentistry	Dentistry	450
4	Nasrin Azad	2	3	Education	Math	Education	250

SID	F Name	L Name	Grade	GPA	Faculty	Department	Building	No of Std
1	Dara	Ahmed	3	3.5	Science	IT	Main	350
2	Zara	Nadim	2	4	Engineering	Architecture	Main	400
3	Nawzad	Ali	4	3.5	Dentistry	Dentistry	Dentistry	450
4	Nasrin	Azad	2	3	Education	Math	Education	250

SID	F Name	L Name	Grade	GPA
1	Dara	Ahmed	3	3.5
2	Zara	Nadim	2	4
3	Nawzad	Ali	4	3.5
4	Nasrin	Azad	2	3

Student

Department	Building	No of Std	Faculty
IT	Main	350	Science
Architecture	Main	400	Engineering
Dentistry	Dentistry	450	Dentistry
Math	Education	250	Education

Department

Normalization Example 2



SID	Full Name	Grade	GPA	Faculty	Department	Building	No of Std	Faculty_Budget
1	Dara Ahmed	3	3.5	Science	IT	Main	350	120.000\$
2	Zara Nadim	2	4	Engineering	Architecture	Main	400	180.000\$
3	Nawzad Ali	4	3.5	Dentistry	Dentistry	Dentistry	450	140.000\$
4	Nasrin Azad	2	3	Education	Math	Education	250	220.000\$

SID	F Name	L Name	Grade	GPA	Faculty	Department	Building	No of Std	Faculty_Budget
1	Dara	Ahmed	3	3.5	Science	IT	Main	350	120.000\$
2	Zara	Nadim	2	4	Engineering	Architecture	Main	400	180.000\$
3	Nawzad	Ali	4	3.5	Dentistry	Dentistry	Dentistry	450	140.000\$
4	Nasrin	Azad	2	3	Education	Math	Education	250	220.000\$

SID	F Name	L Name	Grade	GPA
1	Dara	Ahmed	3	3.5
2	Zara	Nadim	2	4
3	Nawzad	Ali	4	3.5
4	Nasrin	Azad	2	3

Student

Department	Building	No of Std
IT	Main	350
Architecture	Main	400
Dentistry	Dentistry	450
Math	Education	250

Department

Faculty	Faculty_Budget
Science	120.000\$
Engineering	180.000\$
Dentistry	140.000\$
Education	220.000\$

Faculty

Product_name	Price	Employee_name	Employee_Salary
Biskrem	500 IQD	Dara Azad	800 \$
Pop cake	250 IQD	Ahmed Kawa	600 \$
Sprite	500 IQD	Dara Kawa	800 \$



Product_name	Price	Employee_first_name	Employee_last_name	Employee_Salary
Biskrem	500 IQD	Dara	Azad	800 \$
Pop cake	250 IQD	Ahmed	Kawa	600 \$
Sprite	500 IQD	Dara	Kawa	800 \$

Product_ID	Product_name	Price
1	Biskrem	500 IQD
2	Pop cake	250 IQD
3	Sprite	500 IQD

Product

Employee_ID	Employee_first_name	Employee_last_name	Employee_Salary
11	Dara	Azad	800 \$
22	Ahmed	Kawa	600 \$
33	Dara	Kawa	800 \$

Employee

Product_name	Price	Employee_name	Employee_Salary	Customer_name	Customer_address
Biskrem	500 IQD	Dara Azad	800 \$	Zara Mustafa	Shorish
Pop cake	250 IQD	Ahmed Kawa	600 \$	Darya Omer	Azadi
Sprite	500 IQD	Dara Kawa	800 \$	Ali Dana	Baxtiyari



Product_name	Price	Employee_first_name	Employee_last_name	Employee_Salary	Customer_first_name	Customer_last_name	Customer_address
Biskrem	500 IQD	Dara	Azad	800 \$	Zara	Mustafa	Shorish
Pop cake	250 IQD	Ahmed	Kawa	600 \$	Darya	Omer	Azadi
Sprite	500 IQD	Dara	Kawa	800 \$	Ali	Dana	Baxtiyari

Product_ID	Product_name	Price
1	Biskrem	500 IQD
2	Pop cake	250 IQD
3	Sprite	500 IQD

Product

Employee_ID	Employee_first_name	Employee_last_name	Employee_Salary
11	Dara	Azad	800 \$
22	Ahmed	Kawa	600 \$
33	Dara	Kawa	800 \$

Employee

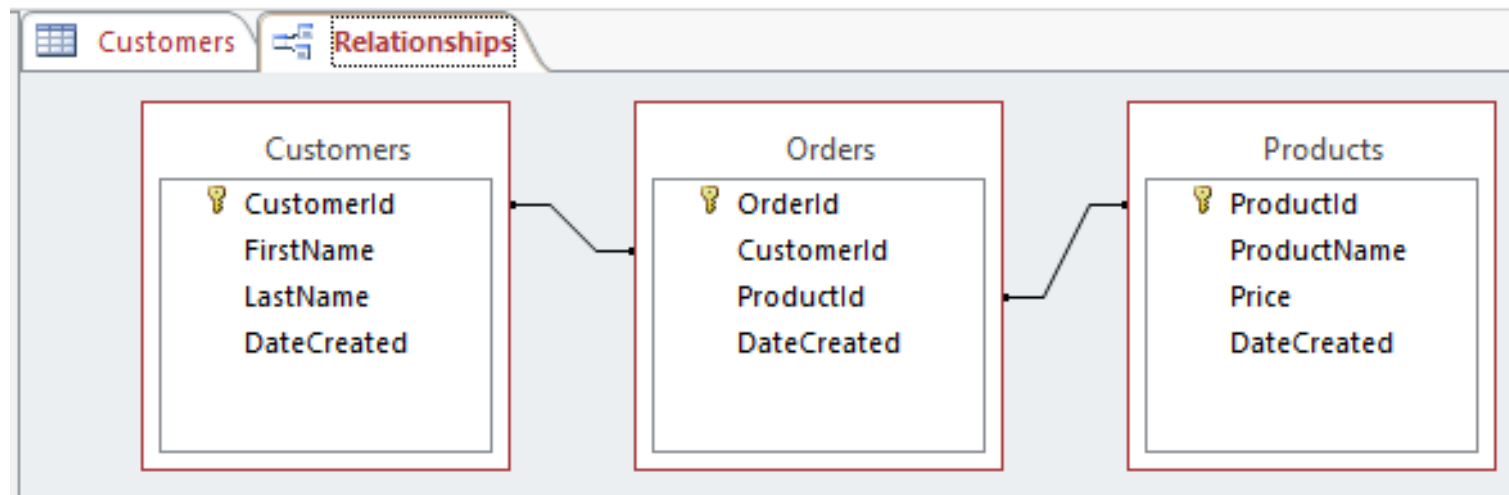
Customer_ID	Customer_first_name	Customer_last_name	Customer_address
1	Zara	Mustafa	Shorish
2	Darya	Omer	Azadi
3	Ali	Dana	Baxtiyari

Customer

Relationships



- They are established to create link between two tables.
- One table uses a foreign key that references the primary key of another table.



Relationships



There are three types of relationships:

- **One-to-One (1-1)** relationship
- **One-to-Many (1-m)** relationship
- **Many-to-Many (m-n)** relationship

One-to-One Relationship



- **One** Student can have only **One** Contact information.
- So the relationship is **One-to-One** between **Student** and **Contact information** tables.
- It is not a common type of relationship.
- E.g.: **Student** ————— **Contact information (SID, Address, Phone)**

One-to-One Relationship

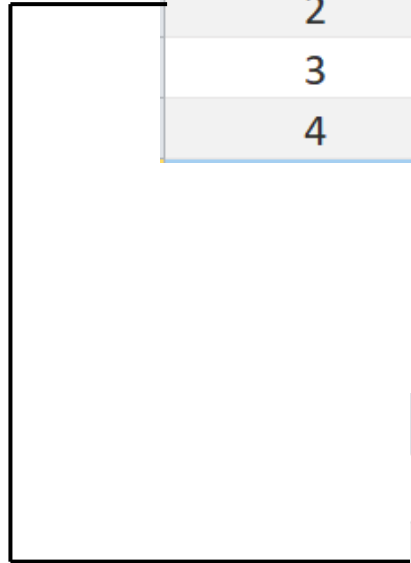


SID	F Name	L Name	Grade	GPA
1	Dara	Ahmed	3	3.5
2	Zara	Nadim	2	4
3	Nawzad	Ali	4	3.5
4	Nasrin	Azad	2	3

Student

SID	House No	Phone
1	3432	(750) 444-4444
2	5643	(751) 555-5555
3	324	(750) 666-6666
4	2345	(751) 777-7777

Student



One-to-Many Relationship



- **One** Department can have **Many** Students.
- So the relationship is **One-to-Many** between **Department** and **Student** tables.
- It is the most common relationship between tables in a relational databases.
- Information about Department and Student are different, but they are related to each other.
- E.g.: **Department** ————< **Students**
Faculty ————< **Departments**

One-to-Many Relationship (cont.)



Department ▾	Building ▾	No of Std ▾
IT	Main	350
Architecture	Main	400
Dentistry	Dentistry	450
Math	Education	250

Department

SID ▾	F Name ▾	L Name ▾	Grade ▾	GPA ▾
1	Dara	Ahmed	3	3.5
2	Zara	Nadim	2	4
3	Nawzad	Ali	4	3.5
4	Nasrin	Azad	2	3

Student

One-to-Many Relationship (cont.)



Primary Key

Department	Building	No of Std
IT	Main	350
Architecture	Main	400
Dentistry	Dentistry	450
Math	Education	250

Department

Primary Key

SID	F Name	L Name	Grade	GPA	Department
1	Dara	Ahmed	3	3.5	IT
2	Zara	Nadim	2	4	Architecture
3	Nawzad	Ali	4	3.5	Dentistry
4	Nasrin	Azad	2	3	Math

Student

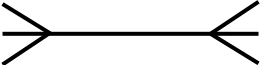
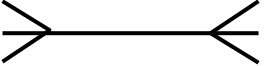
Foreign Key

Department field in Student table is not a primary key but Foreign Key and it is not unique.

Many-to-Many Relationship



- **One** Course can have **Many** Students
And
One Student can have **Many** Courses
- So the relationship is **Many-to-Many** between **Course** and **Student** tables.
- Information about Course and Student are different, but they are related to each other.
- E.g.:

Course		Students
Product		Customer

Many-to-Many Relationship



SID	F Name	L Name	Grade	GPA
1	Dara	Ahmed	3	3.5
2	Zara	Nadim	2	4
3	Nawzad	Ali	4	3.5
4	Nasrin	Azad	2	3

Student

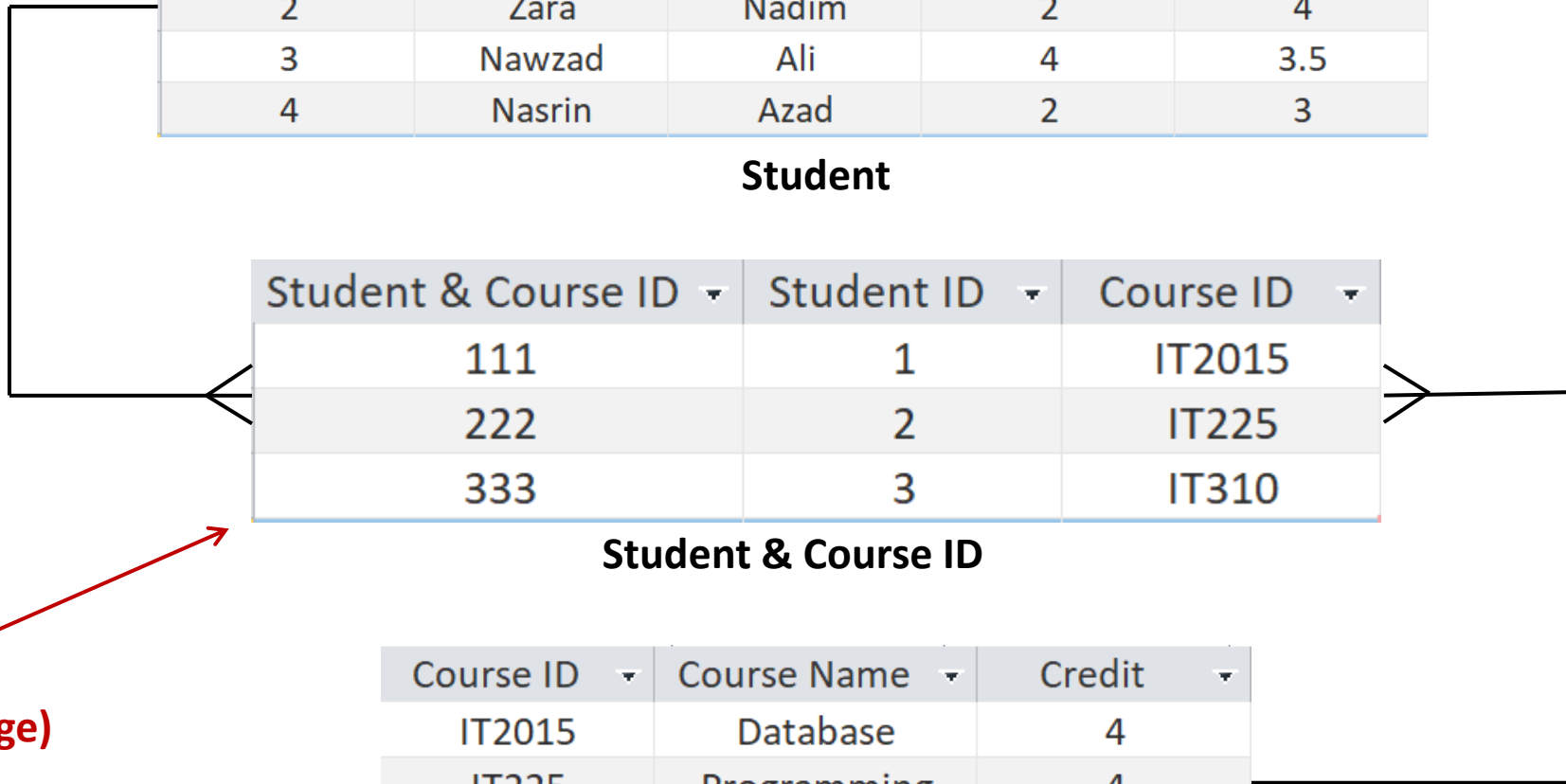
Student & Course ID	Student ID	Course ID
111	1	IT2015
222	2	IT225
333	3	IT310

Student & Course ID

Course ID	Course Name	Credit
IT2015	Database	4
IT225	Programming	4
IT310	Multimedia	3

Course

**Junction (Linkage)
table**





Thank You