

<i>instructor.ID</i>	<i>name</i>	<i>dept_name</i>	<i>salary</i>	<i>teaches.ID</i>	<i>course_id</i>	<i>sec_id</i>	<i>semester</i>	<i>year</i>
10101	Srinivasan	Comp. Sci.	65000	10101	CS-101	1	Fall	2017
10101	Srinivasan	Comp. Sci.	65000	10101	CS-315	1	Spring	2018
10101	Srinivasan	Comp. Sci.	65000	10101	CS-347	1	Fall	2017
12121	Wu	Finance	90000	12121	FIN-201	1	Spring	2018
15151	Mozart	Music	40000	15151	MU-199	1	Spring	2018
22222	Einstein	Physics	95000	22222	PHY-101	1	Fall	2017
32343	El Said	History	60000	32343	HIS-351	1	Spring	2018
45565	Katz	Comp. Sci.	75000	45565	CS-101	1	Spring	2018
45565	Katz	Comp. Sci.	75000	45565	CS-319	1	Spring	2018
76766	Crick	Biology	72000	76766	BIO-101	1	Summer	2017
76766	Crick	Biology	72000	76766	BIO-301	1	Summer	2018
83821	Brandt	Comp. Sci.	92000	83821	CS-190	1	Spring	2017
83821	Brandt	Comp. Sci.	92000	83821	CS-190	2	Spring	2017
83821	Brandt	Comp. Sci.	92000	83821	CS-319	2	Spring	2018
98345	Kim	Elec. Eng.	80000	98345	EE-181	1	Spring	2017

Figure 2.13 Result of $\sigma_{\text{instructor.ID}=\text{teaches.ID}}(\text{instructor} \times \text{teaches})$.

The result of this expression is shown in Figure 2.13. Observe that instructors Gold, Califiori, and Singh do not teach any course (as recorded in the *teaches* relation), and therefore do not appear in the result.

Note that this expression results in the duplication of the instructor's ID. This can be easily handled by adding a projection to eliminate the column *teaches.ID*.

The *join* operation allows us to combine a selection and a Cartesian product into a single operation.

Consider relations $r(R)$ and $s(S)$, and let θ be a predicate on attributes in the schema $R \cup S$. The *join* operation $r \bowtie_{\theta} s$ is defined as follows:

$$r \bowtie_{\theta} s = \sigma_{\theta}(r \times s)$$

Thus, $\sigma_{\text{instructor.ID}=\text{teaches.ID}}(\text{instructor} \times \text{teaches})$ can equivalently be written as $\text{instructor} \bowtie_{\text{instructor.ID}=\text{teaches.ID}} \text{teaches}$.

2.6.6 Set Operations

Consider a query to find the set of all courses taught in the Fall 2017 semester, the Spring 2018 semester, or both. The information is contained in the *section* relation (Figure 2.6). To find the set of all courses taught in the Fall 2017 semester, we write:

$$\Pi_{\text{course_id}} (\sigma_{\text{semester} = \text{"Fall"} \wedge \text{year} = 2017} (\text{section}))$$

To find the set of all courses taught in the Spring 2018 semester, we write:

$$\Pi_{\text{course_id}} (\sigma_{\text{semester} = \text{"Spring"} \wedge \text{year} = 2018} (\text{section}))$$