

To answer the query, we need the **union** of these two sets; that is, we need all *course\_ids* that appear in either or both of the two relations. We find these data by the binary operation union, denoted, as in set theory, by  $\cup$ . So the expression needed is:

$$\Pi_{course\_id} (\sigma_{semester = \text{"Fall"} \wedge year = 2017} (section)) \cup \Pi_{course\_id} (\sigma_{semester = \text{"Spring"} \wedge year = 2018} (section))$$

The result relation for this query appears in Figure 2.14. Notice that there are eight tuples in the result, even though there are three distinct courses offered in the Fall 2017 semester and six distinct courses offered in the Spring 2018 semester. Since relations are sets, duplicate values such as CS-101, which is offered in both semesters, are replaced by a single occurrence.

Observe that, in our example, we took the union of two sets, both of which consisted of *course\_id* values. In general, for a union operation to make sense:

1. We must ensure that the input relations to the union operation have the same number of attributes; the number of attributes of a relation is referred to as its **arity**.
2. When the attributes have associated types, the types of the *i*th attributes of both input relations must be the same, for each *i*.

Such relations are referred to as **compatible** relations.

For example, it would not make sense to take the union of the *instructor* and *section* relations, since they have different numbers of attributes. And even though the *instructor* and the *student* relations both have arity 4, their 4th attributes, namely, *salary* and *tot\_cred*, are of two different types. The union of these two attributes would not make sense in most situations.

The **intersection** operation, denoted by  $\cap$ , allows us to find tuples that are in both the input relations. The expression  $r \cap s$  produces a relation containing those tuples in

<i>course_id</i>
CS-101
CS-315
CS-319
CS-347
FIN-201
HIS-351
MU-199
PHY-101

**Figure 2.14** Courses offered in either Fall 2017, Spring 2018, or both semesters.