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branch(branch_name, branch_city, assets)
customer (ID, customer_name, customer_street, customer_city)
loan (loan_number, branch_name, amount)
borrower (ID, loan_number)
account (account_number, branch_name, balance)
depositor (ID, account_number)

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**Figure 2.18** Bank database.

**2.8** Consider the employee database of Figure 2.17. Give an expression in the relational algebra to express each of the following queries:

- a. Find the ID and name of each employee who does not work for “BigBank”.
- b. Find the ID and name of each employee who earns at least as much as every employee in the database.

**2.9** The **division operator** of relational algebra, “ $\div$ ”, is defined as follows. Let  $r(R)$  and  $s(S)$  be relations, and let  $S \subseteq R$ ; that is, every attribute of schema  $S$  is also in schema  $R$ . Given a tuple  $t$ , let  $t[S]$  denote the projection of tuple  $t$  on the attributes in  $S$ . Then  $r \div s$  is a relation on schema  $R - S$  (that is, on the schema containing all attributes of schema  $R$  that are not in schema  $S$ ). A tuple  $t$  is in  $r \div s$  if and only if both of two conditions hold:

- $t$  is in  $\Pi_{R-S}(r)$
- For every tuple  $t_s$  in  $s$ , there is a tuple  $t_r$  in  $r$  satisfying both of the following:
  - a.  $t_r[S] = t_s[S]$
  - b.  $t_r[R - S] = t$

Given the above definition:

- a. Write a relational algebra expression using the division operator to find the IDs of all students who have taken all Comp. Sci. courses. (Hint: project *takes* to just ID and *course\_id*, and generate the set of all Comp. Sci. *course\_ids* using a select expression, before doing the division.)
- b. Show how to write the above query in relational algebra, without using division. (By doing so, you would have shown how to define the division operation using the other relational algebra operations.)