Problem 1

Specify the following queries on the COMPANY relational database schema shown in Figure 1, using the relational operators.

**EMPLOYEE**

<table>
<thead>
<tr>
<th>Name</th>
<th>Minit</th>
<th>Lname</th>
<th>Ssn</th>
<th>Bdate</th>
<th>Address</th>
<th>Sex</th>
<th>Salary</th>
<th>Super_ssn</th>
<th>Dno</th>
</tr>
</thead>
</table>

**DEPARTMENT**

<table>
<thead>
<tr>
<th>Dname</th>
<th>Dnumber</th>
<th>Mgr_ssn</th>
<th>Mgr_start_date</th>
</tr>
</thead>
</table>

**DEPT_LOCATIONS**

<table>
<thead>
<tr>
<th>Dnumber</th>
<th>Location</th>
</tr>
</thead>
</table>

**PROJECT**

<table>
<thead>
<tr>
<th>Pname</th>
<th>Pnumber</th>
<th>Plocation</th>
<th>Dnum</th>
</tr>
</thead>
</table>

**WORKS_ON**

<table>
<thead>
<tr>
<th>Essn</th>
<th>Pno</th>
<th>Hours</th>
</tr>
</thead>
</table>

**DEPENDENT**

<table>
<thead>
<tr>
<th>Essn</th>
<th>Dependent_name</th>
<th>Sex</th>
<th>Bdate</th>
<th>Relationship</th>
</tr>
</thead>
</table>

Figure 1: Company Schema

1. Retrieve the names of employees in department 5 who work more than 10 hours per week on the 'ProductX' project.

2. List the names of employees who have a dependent with the same first name as themselves.

3. Find the names of employees that are directly supervised by 'Franklin Wong'.

4. Retrieve the names of employees who work on every project.

5. Retrieve the names of employees who do not work on any project.

6. Find the names of employees who work on at least one project located in Houston but whose department has no location in Houston.

7. List the last names of department managers who have no dependents.

**Solution:**

In the relational algebra, as in other languages, it is possible to specify the same query in multiple ways. We give one possible solution for each query. We use the symbol $\sigma$ for SELECT, $\pi$ for PROJECT, $\bowtie$ for EQUIJOIN, * for NATURAL JOIN.
1. EMP_W_X ← (σPname='ProductX' (PROJECT))×σPNumber=PnO (WORKS_ON)
   EMP_WORK_10 ← (EMPLOYEE)×σSsn=Essn (σHours>10 (EMP_W_X))
   RESULT ← πLname,Fname (σDno=5 (EMP_WORK_10))

2. E ← (EMPLOYEE)×σ{Ssn,Fname} = (Essn,Dependent_name) (DEPENDENT)
   R ← πLname,Fname (E)

3. WONG_SSN ← πSsn (σFname='Franklin' AND Lname='Wong' (EMPLOYEE))
   WONG_EMPS ← (EMPLOYEE)×σSUPERSSN=SSN (WONG_SSN)
   RESULT ← πLname,Fname (WONG_EMPS)

4. PROJ_EMPS(PNO,SSN) ← σPNO,ESSN (WORKS_ON)
   ALL_PROJS(PNO) ← πPnumber (PROJECT)
   EMPS_ALL_PROJS ← PROJ_EMPS ÷ ALLPROJS
   RESULT ← πLname,Fname (EMPLOYEE * EMP_ALL_PROJS)

5. ALL_EMPS ← πSSN (EMPLOYEE)
   WORKING_EMPS(SSN) ← πEssn (WORKS_ON)
   NON_WORKING_EMPS ← ALL_EMPS - WORKING_EMPS
   RESULT ← πLname,Fname (EMPLOYEE * NON_WORKING_EMPS)

6. E_P_HOU(SSN) ← πEssn (WORKS_ON ⊙σPNO =PNumber (σPlocations='Houston' (PROJECT)))
   D_NO_HOU ← πDnumber (DEPARTMENT) - πDnumber (σDlocations='Houston' (DEPARTMENT))
   E_D_NO_HOU ← πSsn (EMPLOYEE ⊙σDno=Dnumber (D_NO_HOU))
   RESULT_EMPS ← E_P_HOU ∩ E_D_NO_HOU
   RESULT ← πLname,Fname,Address (EMPLOYEE * RESULT_EMPS)

7. DEPT_MANAGERS(SSN)← πMgr_ssn (DEPARTMENT)
   EMPS_WITH_DEPENDENTS(SSN) ← πEssn (DEPENDENT)
   RESULT_EMPS ← DEPT_MANAGERS - EMPS_WITH_DEPENDENTS
   RESULT ← πLname (EMPLOYEE * RESULT_EMPS)