Note that two solutions are given for each problem, one in “standard” relational algebra and the other in a syntactically-sugared variety of that language. In the former, the notation $\rho_n(E)$ indicates that $n$ will be used to refer to the table given by expression $E$. The corresponding notation in the latter is “$E$ AS $n$”.

Using the COMPANY database (as illustrated in Figure 5.6 of the Elmasri/Navathe textbook), devise solutions, in Relational Algebra, to the following informally-stated queries:

1. Retrieve the first and last names of any employee who is male and has a salary greater than $45,000.$

**Solution:** $\pi_{Fname, Lname}(\sigma_{Sex='M' \land Salary>45000}(Employee))$

\[\text{PROJECT Fname, Lname}
\text{FROM (RESTRICT Employee WHERE Sex = 'M' \land Salary > 45000)}\]

2. Retrieve the name and birthdate of anyone who is either a female dependent of an employee who works for Department 3 or a dependent (of either sex) of an employee who works for Department 4.

**Solution:**

\[\pi_{Dependent \_ name, Bdate}(\sigma_{Dno=3(Employee) \bowtie_{Ssn=Essn} \sigma_{Sex='F'}(Dependent)) \cup \\
(\sigma_{Dno=4(Employee) \bowtie_{Ssn=Essn} Dependent}))\]

\[\text{PROJECT Dependent \_ name, Bdate}
\text{FROM ((JOIN (RESTRICT Employee WHERE Dno = 3) \\
\text{WITH (RESTRICT Dependent WHERE Sex = 'F') \\
\text{WHERE Ssn = Essn }) \\
\text{UNION }) (JOIN (RESTRICT Employee WHERE Dno = 4) \\
\text{WITH Dependent \\
\text{WHERE Ssn = Essn }))} \]
3. Retrieve the last name of any employee who works for a different department than does her/his direct supervisor.

**Solution:** \(\pi_{e.\text{Lname}}(\rho_{e}(\text{Employee}) \bowtie_{e.\text{Super}_\text{ssn}=s.\text{Ssn} \land e.\text{Dno}\neq s.\text{Dno}} \rho_s(\text{Employee}))\)

\[
\text{PROJECT } e.\text{Lname} \\
\text{FROM JOIN Employee AS } e \text{ WITH Employee AS } s \\
\text{WHERE } e.\text{Super}_\text{ssn} = s.\text{Ssn} \land e.\text{Dno} \neq s.\text{Dno}
\]

4. Retrieve the last name and birthdate of any employee who is no one’s direct supervisor.

**Solution:**

\[
\pi_{\text{Lname}, \text{Bdate}}(\rho_{e}(\text{Employee}) \bowtie_{e.\text{Ssn}=\pi_{\text{Ssn}}(\text{Employee}) - \pi_{\text{Super}_\text{ssn}}(\text{Employee}))\))
\]

\[
\text{PROJECT Lname, Bdate} \\
\text{FROM JOIN Employee AS } e \\
\text{WITH ((PROJECT Ssn FROM Employee) EXCEPT (Project Super_Ssn FROM Employee) ) AS ns} \\
\text{WHERE e.Ssn = ns.Ssn}
\]

5. Retrieve the last name and birthdate of any employee who works on a project that is controlled by a department different from the one for which the employee works.

**Solution:** \(\pi_{\text{Lname}, \text{Bdate}}((\text{Employee} \bowtie_{\text{Ssn}=\text{Essn} \text{ WorksOn}} \bowtie_{\text{Dno}\neq \text{Dnum}} \text{ Project})\)

\[
\text{PROJECT Lname, Bdate} \\
\text{FROM (JOIN (JOIN Employee WITH WorksOn WHERE Ssn = Essn) WITH Project) WHERE Dno \neq Dnum)}
\]