1. Given two relations $R_1$ and $R_2$, where $R_1$ contains $N_1$ tuples and $R_2$ contains $N_2$ tuples, and $N_2 > N_1 > 0$, give the maximum and minimum possible sizes (in tuples) for the result relation produced by each of the following relational algebra expressions. In each case, state any assumptions about the schemas for $R_1$ and $R_2$ that are needed to make the expression meaningful.

   (a) $R_1 \cup R_2$
   (b) $R_1 \cap R_2$
   (c) $R_1 - R_2$
   (d) $R_1 \times R_2$
   (e) $\sigma_{a=5}(R_1)$
   (f) $\Pi_{a}(R_1)$
   (g) $R_1/R_2$

2. Consider the following schema where the primary keys are underlined.

   employee(person-name, street, city)
   works(person-name, company-name, salary)
   company(company-name, city)
   manages(person-name, manager-name)

   (a) Write relational algebra expressions for the following queries.

   i. Find the names of all employees who work for First Bank Corporation.

   ii. Find the names and cities of residence of all employees who work for First Bank Corporation.

   iii. Find the names, street address, and cities of residence of all employees who work for First Bank Corporation and earn more than $100,000 per annum.
iv. Find the names of all employees in this database who live in the same city as the company for which they work.

v. Find the names of all employees who live in the same city and on the same street as do their manager.

vi. Find the names of all employees in this database who do not work for First Bank Corporation.

(b) Write relational algebra expressions for the following data modification operations.

i. Modify the database so that Jones now lives in Newton.

ii. Give all employees of First Bank Corporation a 10% salary raise.

iii. Give all managers in this database a 10% salary raise.

iv. Give all managers in this database a 10% salary raise, unless the salary would be greater than 100,000. In such cases, give only a 3% raise.

v. Delete all tuples in works relation for employees of Small Bank Corporation.

(c) Write queries using extended relational algebra.

i. Find the company name with the most employees.

ii. Find the company with the smallest payroll.

iii. Find those companies whose employees earn a higher salary, on average, than the average salary at First Bank Corporation.

(d) For each of the above operations, given in questions 2(a), (b), and (c), write their equivalent forms in SQL.

(e) Try these relational queries on PostgreSQL on sample tables and check your answers. This is for your own knowledge – you do not have to submit question 2(e).

3. Which of the relational operators and extended relational are supported by PostgreSQL?

Please keep in mind:

- This assignment is to be done individually. The honor code is in effect.
- Submission must be made through RamCT by Monday, March 9.
- No late work will be accepted except in exigent situations.
- Your answers must be typed.