Practice Relational Query Languages Question

1. Consider the following relational database:

   employee(e-name, street, city)
   works(e-name, c-name, salary)
   company(c-name, city)
   manages(e-name, m-name)

   For each of the following queries, give an expression in

   i) the relational algebra,
   ii) the tuple relational calculus,
   iii) the domain relational calculus.

   For example, the following expressions would be used to find the names of all employees who work for the First Bank Corporation:

   i) $\Pi_{e\text{-}name}(\sigma_{c\text{-}name = \text{'First Bank Corporation'}}(works))$

   ii) $\{t \mid \exists\ s \in works\ (t[e\text{-}name] = s[e\text{-}name] \wedge s[c\text{-}name] = \text{"First Bank Corporation"})\}$

   iii) $\{<p> \mid \exists\ c, s\ (<p, c, s> \in works \wedge c = \text{"First Bank Corporation"})\}$

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

   i) $\Pi_{e\text{-}name,\ city}(employee \bowtie (\sigma_{c\text{-}name = \text{'First Bank Corporation'}}(works)))$

   ii) $\{t \mid \exists\ r \in employee\ \exists\ s \in works\ (t[e\text{-}name] = r[e\text{-}name] \wedge t[city] = r[city] \wedge r[e\text{-}name] = s[e\text{-}name] \wedge s[c\text{-}name] = \text{"First Bank Corporation"})\}$

iii) $\{<p, c> \mid \exists\ co, sa, st\ (<p, co, sa> \in works$

$\wedge$ <p, st, c> $\in$ *employee*

$\wedge$ *co* = "First Bank Corporation")}

b) Find the names, street address, and cities of all employees who work for First Bank Corporation and earn more than $10,000 per annum. Assume each person works for at most one company.

i) $\Pi_{e\text{-}name,\ street,\ city}\ (\sigma_{(c\text{-}name = \text{'First Bank Corporation'} \wedge salary > 10000)}$

works $\bowtie$ *employee*)

ii) $\{t \mid t \in employee \wedge (\exists\ s \in works\ (s[e\text{-}name] = t[e\text{-}name]$

$\wedge\ s[c\text{-}name] =$ "First Bank Corporation"

$\wedge\ s[salary] > 10000))\}$

iii) $\{<p, s, c> \mid <p, s, c> \in employee$

$\wedge\ \exists\ co, sa\ (<p, co, sa> \in works$

$\wedge\ co$ = "First Bank Corporation" $\wedge\ sa > 10000)\}$

c) Find the names of all employees in this database who live in the same city as the company for which they work.

i) $\Pi_{e\text{-}name}\ (employee \bowtie works \bowtie company)$

ii) $\{t \mid \exists\ e \in employee\ \exists\ w \in works\ \exists\ c \in company$

$(t[e\text{-}name] = e[e\text{-}name]$

$\wedge\ e[e\text{-}name] = w[e\text{-}name]$

$\wedge\ w[c\text{-}name] = c[c\text{-}name] \wedge e[city] = c[city]$

iii) $\{<p> \mid \exists\ st, c, co, sa\ (<p, st, c> \in employee$

$\wedge <p, co, sa> \in works$

$\wedge\ <co, c> \in company)\}$

d) Find the names of all employees who live in the same city and on the same street as do their managers.

i) $\Pi_{e\text{-}name}\,(employee \bowtie manages)$

$\bowtie$ (m-name=employee2.e-name $\wedge$ employee.street = employee2.street

$\wedge$ employee.city = employee2.city) $(\rho_{employee2}(employee)))$

ii) $\{t \mid \exists\, l \in employee\ \exists\, m \in manages\ \exists\, r \in employee$

$(l[e\text{-}name] = m[e\text{-}name] \wedge m[m\text{-}name] = r[e\text{-}name]$

$\wedge\ l[street] = r[street] \wedge l[city] = r[city]$

$\wedge\ t[e\text{-}name] = l[e\text{-}name])\}$

iii) $\{<t> \mid \exists\, s, c, m\ (<t, s, c> \in employee$

$\wedge\ <t, m> \in manages$

$\wedge\ <m, s, c> \in employee)\}$

e) Find the names of all employees in this database who do not work for the First Bank Corporation. Assume that all people work for exactly one company.

i) $\Pi_{e\text{-}name}\,(\sigma_{c\text{-}name \neq \text{'First Bank Corporation'}}\,(works))$

ii) $\{t \mid \exists\, w \in works\ (w[c\text{-}name] \neq$ 'First Bank Corporation'

$\wedge\ t[e\text{-}name] = w[e\text{-}name])\}$

iii) $\{<p> \mid \exists\, c, s\ (<p, c, s> \in works$

$\wedge\ c \neq$ 'First Bank Corporation')$\}$

f) Find the name of all employees who earn more than every employee of Small Bank Corporation. Assume that all people work for at most one company.

i) $\Pi_{e\text{-}name}(works) - (\Pi_{works.e\text{-}name}$
$(works \bowtie_{(works.salary \leq works2.salary \wedge works2.c\text{-}name = 'Small\ Bank\ Corporation')}$
$\rho_{works2}(works)))$

ii) $\{t \mid \exists\ w \in works\ (t[e\text{-}name] = w[e\text{-}name] \wedge \forall\ s \in works$
$(s[c\text{-}name] = 'Small\ Bank\ Corporation'$
$\Rightarrow w[salary] > s[salary]))\}$

iii) $\{<p> \mid \exists\ c, s\ (<p, c, s> \in works \wedge \forall\ p2, c2, s2$
$(<p2, c2, s2> \in works$
$\wedge\ c2 = 'Small\ Bank\ Corporation' \Rightarrow s > s2))\}$

g) Assume the companies may be located in several cities. Find all companies located in every city in which Small Bank Corporation is located.

i) $\Pi_{c\text{-}name}(company \div$
$(\Pi_{city}(\sigma_{c\text{-}name = 'Small\ Bank\ Corporation'}(company))))$

ii) $\{t \mid \forall s \in company(s[c\text{-}name] = 'Small\ Bank\ Corporation' \Rightarrow$
$\exists\ r \in company\ (t[c\text{-}name] = r[c\text{-}name]$
$\wedge\ r[city] = s[city]))\}$

iii) $\{<co> \mid \forall\ co2, ci2\ (<co2, ci2> \in company$
$\wedge\ co2 = 'Small\ Bank\ Corporation' \Rightarrow$
$<co2, ci2> \in company)\}$

(From text, question 3.5)

2. Let R = (A, B) and S = (A, C), and let r(R) and s(S) be relations. The relational algebra expression $\Pi_A(\sigma_{B=10}(r))$ is equivalent to the following domain relational calculus expression:

   $\{<a> \mid \exists\, b\, (<a, b> \in r \wedge b = 10)\}$

   Give an expression in the domain relational calculus that is equivalent to each of the following:

a) $r \bowtie s$

   $\{<a, b, c> \mid <a, b> \in r \wedge <a, c> \in s\}$

b) $\Pi_{r.A}((r \bowtie s) \bowtie_{c=r2.A \wedge r.B>r2.B} (\rho_{r2}(r)))$

   $\{<a> \mid \exists c\, (<a, c> \in s) \wedge \exists b_1, b_2\, (<a, b_1> \in r \wedge <c, b_2> \in r \wedge b_1 > b_2)\}$