1). 15 points

<table>
<thead>
<tr>
<th>Expression</th>
<th>Assumption</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_1 \cup R_2$</td>
<td>$R_1$ and $R_2$ are union-compatible</td>
<td>$N_2$</td>
<td>$N_1 + N_2$</td>
</tr>
<tr>
<td>$R_1 \cap R_2$</td>
<td>$R_1$ and $R_2$ are union-compatible</td>
<td>0</td>
<td>$N_1$</td>
</tr>
<tr>
<td>$R_1 - R_2$</td>
<td>$R_1$ and $R_2$ are union-compatible</td>
<td>0</td>
<td>$N_1$</td>
</tr>
<tr>
<td>$R_1 \times R_2$</td>
<td></td>
<td>$N_1 \ast N_2$</td>
<td>$N_1 \ast N_2$</td>
</tr>
<tr>
<td>$\sigma a = 5 (R_1)$</td>
<td>$R_1$ has an attribute named $a$</td>
<td>0</td>
<td>$N_1$</td>
</tr>
<tr>
<td>$\pi a (R_1)$</td>
<td>$R_1$ has an attribute named $a$, $N_1 &gt; 0$</td>
<td>1</td>
<td>$N_1$</td>
</tr>
<tr>
<td>$R_1 / R_2$</td>
<td>The set of attributes of $R_2$ is a subset of the set of attributes of $R_1$</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

2a). 5X6 = 30 points

(I) $\pi_{\text{person-name}}(\sigma_{\text{company-name} = 'First Bank Corporation'}(\text{works}))$

(II) $\pi_{\text{person-name}, \text{city}}((\sigma_{\text{company-name} = 'First Bank Corporation'}(\text{works})) \text{ employee})$

(III) $\pi_{\text{person-name}, \text{street}, \text{city}}((\sigma_{\text{company-name} = 'First Bank Corporation'} \land \text{salary} > 100000(\text{works})) \text{ employee})$

(IV) $\pi_{\text{person-name}}(\text{works company employee})$

(V) $\rho(\text{all-persons, (manages employee)})$

   $\rho(\text{manager-details, (manages manages.manager-name = employee.person-name employee})$

   $\pi_{\text{person-name}}(\text{all-persons} \land \text{all-persons.street} = \text{manager-details.street} \land \text{all-persons.city} = \text{manager-details.city})$

(VI) $\pi_{\text{person-name}}(\sigma_{\text{company-name} \neq 'First Bank Corporation'}(\text{works}))$

2b). 5x5 = 25 points

(I) $\text{EMPLOYEE} ← \sigma_{\text{person-name} \neq 'Jones'}(\text{EMPLOYEE}) \cup \pi_{\text{person-name}, \text{street}, 'Newton'}(\sigma_{\text{person-name} = 'Jones'}(\text{EMPLOYEE}))$

(II) $\text{WORKS} ← \sigma_{\text{company-name} \neq 'First Bank Corporation'}(\text{WORKS}) \cup \pi_{\text{person-name}, \text{company-name}, 1.1}\ast\text{salary}(\sigma_{\text{company-name} = 'First Bank Corporation'}(\text{WORKS}))$

(III) $\text{temp-manages1} ← \pi_{\text{person-name}, \text{company-name}, \text{salary}}(\sigma_{\text{manager.manager-name} = \text{works.person-name}}(\text{works} \times \text{manages}))$

$\text{temp-manages2} ← \pi_{\text{person-name}, \text{company-name}, \text{salary}}(1.1\ast(\text{temp-manages1}))$

$\text{works} ← (\text{works} \times \text{temp-manages1}) \cup \text{temp-manages2}$

(IV) $\text{temp-manages1} ← \pi_{\text{person-name}, \text{company-name}, \text{salary}}(\sigma_{\text{manager.manager-name} = \text{works.person-name}}(\text{works} \times \text{manages}))$
manages ))
temp-manages2 ← πperson-name, company-name, salary * 1.1 (σsalary * 1.1 ≤ 100000 (temp-manages1 ))
temp-manages3 ← πperson-name, company-name, salary * 1.03 (σsalary * 1.1 > 100000 (temp-manages1 ))
works ← ( works – temp-manages1 ) temp-manages2 temp-manages3

(V) works ← works – (σ company-name = “Small Bank Corporation” (works ))

2c. 5X3 = 15 points
(I) temp_table1 ← company-name G count(person-name) (WORKS)
temp_table2 ← G max(numEmp) ρ (Company_temp (1 ← company, 2 ← numEmp), temp_table1)
πcompany (ρ (temp_table3 (1 ← company, 2 ← numEmp), temp_table1)
ρ (temp_table4 (1 ← numEmp), temp_table2))

(II) temp1 ← company-name G sum(salary) (works)
temp2 ← G min(numSal) (ρ (compPay (1 ← company, 2 ← numSal), temp1))
πcompany (ρ (temp3 (1 ← company, 2 ← numSal), temp1) ρ (temp4 (1 ← numSal), temp2))

(III) temp1 ← company-name G avg(salary) (works)
temp2 ← G company-name = “First Bank Corporation” (ρ (compAvg (1 ← company, 2 ← avgSal), temp1))
πtemp3.company (ρ (temp3 (1 ← company, 2 ← avgSal), temp1) ρ (temp3.avgSal > FBC.avgSal, temp2))

2d. 10 points
2-A)-i)
SELECT PERSON-NAME FROM WORKS WHERE COMPANY-NAME = “First Bank Corporation”
2-A)-ii)
2-A)-iii)
SELECT E.PERSON-NAME, E.STREET, E.CITY FROM WORKS W, EMPLOYEE E WHERE W.COMPANY-NAME = “First Bank Corporation” AND W.SALARY > 100000
2-A)-iv)
SELECT E.PERSON-NAME FROM EMPLOYEE E, WORKS W, COMPANY C WHERE E.PERSON-NAME = W.PERSON-NAME AND W.COMPANY-NAME = C.COMPANY-NAME AND E.CITY = C.CITY
2-A)-v)
SELECT E.PERSON-NAME FROM MANAGES M INNER JOIN EMPLOYEE E ON E.PERSON-NAME = M.PERSON-NAME INNER JOIN EMPLOYEE EMON EM.PERSON-NAME = M.MANAGER-NAME WHERE E.STREET = EM.STREET AND E.CITY = EM.CITY
A)-vi)
SELECT PERSON-NAME FROM WORKS WHERE COMPANY-NAME != "First Bank Corporation"

2-B)-i)
UPDATE EMPLOYEE SET CITY = "Newton" WHERE PERSON-NAME = "Jones"

2-B)-ii)
UPDATE WORKS SET SALARY = SALARY * 1.1 WHERE COMPANY-NAME = "First Bank Corporation"

2-B)-iii)
UPDATE WORKS W SET W.SALARY = W.SALARY * 1.1 WHERE W.PERSON-NAME IN (SELECT DISTINCT M.MANAGER NAME FROM MANAGES M)

2-B)-iv)
UPDATE WORKS W, MANAGES M SET W.SALARY = CASE WHEN (W.SALARY <= 100000) THEN W.SALARY * 1.1 ELSE W.SALARY * 1.03 WHERE W.PERSON-NAME IN (SELECT DISTINCT M.MANAGER-NAME FROM MANAGES M)

2-B)-v)
DELETE FROM WORKS WHERE COMPANY-NAME = "First Bank Corporation"

2-C)-i)
SELECT COMPANY-NAME FROM WORKS GROUP BY COMPANY-NAME HAVING MAX(COUNT(*/))

2-C)-ii)
SELECT COMPANY-NAME FROM WORKS GROUP BY COMPANY-NAME HAVING MIN(SUM(SALARY))

2-C)-iii)
SELECT COMPANY-NAME FROM WORKS GROUP BY COMPANY-NAME HAVING AVG(SALARY) > (SELECT AVG(SALARY) AS AVERAGE_SALARY FROM WORKS GROUP BY COMPANY-NAME WHERE COMPANY-NAME = "First Bank Corporation") AND COMPANY-NAME != "First Bank Corporation"

3). 5 points
Operators Supported:
Arithmetic: =, <>, >, <, >=, <=.
Set: difference, Union, Intersection.
Aggregate Functions: avg, min, max, sum, count.
Joins: Inner join, Outer join, Left outer join, Right outer join, Full outer join