CS 353 Spring 2018
Homework 2
Due: 28 February, Wednesday till 17:00

Q.1 (12 pts, 6 pts each)
(a) Consider relation *R* with n tuples. How many tuples are returned in the resulting relation of $R \bowtie R$?
(b) Express $R \bowtie S$, with *R(A, B, C)* and *S(C, D, E),* in terms of the other **Relational Algebra** operators.

Q.2 (12 pts, 6 pts each) Consider relation *R*(X, Y) with n tuples and *S*(Z, X) with m tuples. What are the minimum and maximum number of tuples returned in the resulting relation of $R \bowtie S$? If:
(a) X is a primary key of relation *R*.
(b) X is a foreign key of relation *S* referencing relation *R*.

Q.3 (10 pts) Let *R* and *S* be relations on attribute set *A1* and *X* is a relation on attribute set *A2*, where $A1 \supset A2$.
Prove or disprove the following: $(R \cup S) \div X = (R \div X) \cup (S \div X)$

Q.4 (24 pts, 6 pts each) Consider the following relational database:

Flight (<u>flight-no</u>, source-airport, destination-airport)
Reservation (<u>passenger-ssn, flight-no</u>, class)
Airport (<u>airport-name</u>, city)

Explain in words what results are returned by the following **Relational Algebra** expressions:
(a) $\prod_{\text{flight-no}} (\sigma_{\text{source-airport} = \text{“Esenboga”} \wedge \text{destination-airport} = \text{“Ataturk”}} (\text{Flight}))$
(b) $\prod_{\text{flight-no}} (\sigma_{\text{source-airport} = \text{airport-name} \wedge \text{city} = \text{“Istanbul”}} (\text{Flight X Airport}))$
(c) $\text{flight-no}\ \mathcal{G}_{\text{count(passenger-ssn)}} (\sigma_{\text{class} = \text{“business”}} (\text{Reservation}))$
(d) $\prod_{\text{flight-no}} (\sigma_{\text{pass-count} > 100} (\text{Flight-no}\ \mathcal{G}_{\text{count(passenger-ssn) as pass-count}} (\sigma_{\text{source-airport} = \text{“Esenboga”}} (\text{Reservation} \bowtie \text{Flight}))))$

Q.5 (42 pts, 6 pts each) Consider the following relational database:

products(<u>p-id</u>, pname, city)
suppliers(<u>s-id</u>, sname)
supply(<u>s-id, p-id</u>, quantity)

Provide a **Relational Algebra** expression for each of the following queries.
(a) Find the names of the suppliers who have supplied a product from Ankara.
(b) Find the names of the suppliers who have not supplied any product from Ankara.
(c) Determine the number of times each product is supplied from Ankara.
(d) Find the products which have been supplied more than 100 times.
(e) Find the product with the highest average quantity of supply.
(f) Find the names of the suppliers who have supplied product with p-id P1 in the highest amount of quantity. Do not use any aggregate function in your expression.
(g) Give an expression for the above query (in part (c)) using aggregate functions.