Name:

Section (315/415):

MIDTERM EXAM - 600.315/415 - Databases

Date: November 8, 2016, 3:00 PM

The total number of points in this exam is 74 for 600.315 students, and 79 for 600.415 students. If you work at approximately 1 minute per point, you should finish on time.

Some questions should only be done by 600.415 or 600.315 students and are marked so.

Question 1 - Relational Algebra (5 points)

Express the following query in the Relational Algebra. The tables that are used in this (and following) questions are found on your supplementary handout.

• (5 points - 600.315 only) List the country in the database where all of the senators are women.

• (5 points - 600.415 only) List the country in the database where all of the senators are women but the head of government is not a woman.
Question 2 - Relational Algebra (5 points)

- (5 points - 600.315 only) List the countries in the database that are in NATO but do not have a female head of government.

- (5 points - 600.415 only) List the countries in the database that are in NATO but do not border another NATO country.
Question 3 - Tuple Relational Calculus (5 points)

Express the following query in Tuple Relational Calculus:

- (5 points) Print the name and GDP of all countries that border Austria or have a female head of government but not both.

Question 4 - Relational Algebra (5 points)

Express the following query in the relational algebra.

(a) (5 points) List the full names of all people who are either (a) a president, (b) directly related to a president, or (c) directly related to someone who is directly related to a president.
Question 5 - Relational Algebra (5 points)

Express the following query in the relational algebra:

(a) (5 points - 600.415 only) List the names and populations of all countries that have a smaller GDP than every country that they border.

SKIP THIS QUESTION - DO NOT ANSWER

Question 6 - Relational Algebra (6 points)

Express the following query in the relational algebra:

List the full names of all politicians in the database who have a mother who also is a politician in the same country.
Question 7 - SQL (25 points)

Express the following queries in SQL:

(a1 - 5 points) - **600.315 only** List the name, GDP and population of the country with the youngest head of government in the database.

(a2 - 5 points) - **600.415 only** List the name, GDP and population of the NATO country with the youngest head of government in the database.

(b - 5 points) List the names of all countries that do not border Russia directly, but border a country that borders Russia.
(c - 5 points) For each continent, list the name of the country with the lowest literacy rate in the continent (along with the name of the continent).

Your output should be a single table and not use multiple queries.

(d - 5 points) List the pair of bordering countries with the greatest absolute difference in life expectancy (give both names and do not repeat them).
(e1 - 5 points) - **600.315 only** List the country in the database where the highest percentage of listed politicians are women.

(e2 - 5 points) - **600.415 only** List the country in the database where the highest percentage of listed politicians are women but do not have a female head of government.
Question 8 - QBE (10-15 points)

Express the following queries in QBE. To simplify your work, table shells have been provided. Just fill in the appropriate cells with variables/values.

(a) (5 points) List the name and continent of every country that borders a country that borders a country that borders a country that has a female prime minister.

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>CName</th>
<th>Continent</th>
<th>GDP</th>
<th>Population</th>
<th>LitRate</th>
<th>LifeExp</th>
</tr>
</thead>
<tbody>
<tr>
<td>BORDERS</td>
<td>Country1</td>
<td>Country2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POLITICIAN</th>
<th>PName</th>
<th>Gender</th>
<th>Office</th>
<th>Country</th>
<th>Age</th>
</tr>
</thead>
</table>

(b) (5 points) List the name and gender of all politicians who are prime ministers of a country and older than the prime minister or president of at least one country that they border.

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>CName</th>
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<th>Population</th>
<th>LitRate</th>
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</tr>
</thead>
</table>
(c) (5 points - 600.415 only) List the name of all continents that contain at least two countries that do not border each other. (600.415 only)

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</table>
Question 10 - Functional Dependencies (14 points)

(a) List at least 10 additional non-trivial functional dependencies that hold for schema R = (A, B, C, D, E) if the following list hold for R (i.e. a subset of the closure). For extra credit, list as many additional non-trivial FD’s as possible. It is recommended that you focus on additional FD’s that will help you answer (b) below.

\[ C \rightarrow AE \]
\[ E \rightarrow D \]
\[ B \rightarrow C \]
\[ AD \rightarrow B \]

(b) List the candidate keys for R.

(c) Show that the decomposition of the schema R above into (A,C,E) and (B,C,D) is a lossless-join decomposition if the set of functional dependencies above hold on R.
CERTIFICATION PAGE

By signing below, I promise that my answers on this exam are entirely my own work. I have not looked at the answers written by others and I have not allowed others to look at my answers.

My Signature: