Full name: _____

CSC336: John Connor — Midterm

The midterm is worth a total of **100 points**.

R =

A	B	C
1	3	7
2	4	8
2	5	8
1	6	9

S =

C	D
7	3
3	3
8	4
9	5

T =

D	E
3	1
7	3
6	2
5	4

1. (a) (5 points) Write the result of the query:

```
SELECT * FROM R NATURAL JOIN S NATURAL JOIN T WHERE T.E <= S.D;
```

(b) (5 points) Rewrite the previous SQL query as a relational algebra query.

(c) (5 points) Write the result of the query:

```
SELECT * FROM R, S, T WHERE R.B < 5 AND S.C < 7 AND T.E > 3;
```

(d) (5 points) Rewrite the previous SQL query as a relational algebra query.

2. (5 points) List all of the super-keys of the relation $R(A, B, C, D, E)$ with keys ABD and ABE. (That is, the relation has two keys: the aggregate key ABD, and the aggregate key ABE.)

3. (10 points) What is the closure of $\{A, B\}$ in $R(A, B, C, D, E, F, G)$ with respect to the following sets of functional dependencies:

   (a) $C \to ABD$ $\quad ABCDEF \to G$ $\quad ABCD \to E$ $\quad AB \to C$

   (b) $D \to A$ $\quad D \to EF$ $\quad ABE \to CG$ $\quad A \to B$ $\quad AB \to C$

4. (15 points) For each of the following questions, if the schema $R(A, B, C, D, E, F)$ is in BCNF or 3NF with respect to the given the functional dependencies, draw a circle around BCNF or 3NF as appropriate.

   (a) BCNF $\quad$ 3NF $\quad ABC \to DEF$ $\quad D \to AB$ $\quad F \to C$

   (b) BCNF $\quad$ 3NF $\quad A \to BCDE$ $\quad B \to ACDE$

   (c) BCNF $\quad$ 3NF $\quad AF \to BCDE$ $\quad BF \to ACDE$

5. (15 points) Use the algorithm given in class to compute the 3NF for $R(A, B, C, D, E, F)$ with the following FDs.

   (a) $A \to ABC \qquad A \to DC \qquad E \to AF$

   (b) $A \to BC \qquad E \to BCD \qquad B \to CD$

   (c) $A \to BD \qquad EC \to F$

6. (15 points) Write a SQL query and a relational algebra expression using the following schemas:

$R(\underline{A\ B}\ C\ D)$
$S(\underline{A}\ E\ F)$ $\qquad \pi_A(S) \subseteq \pi_A(R)$
$T(\underline{A\ B}\ G\ H)$ $\qquad \pi_{AB}(T) \subseteq \pi_{AB}(R)$

   Write the shortest and simplest queries and expressions that you can think of.

   GOOD: $R \bowtie T$

   BAD: $\pi_{ABCDEF}(R \bowtie_{A=A,\ B=B} S)$

   (a) Every combination of the tuples in R with the tuples in S joined with $T.G$ and $T.H$ where $T.A = R.A$ and $R.B = T.B$, but only where $S.A < T.A$.

   (b) The product of R with S, but only where $R.D < S.F$ and $R.D$ renamed to "foo".

7. (20 points) Design a database for a "wildlife rehabilitation center". It should include a registry of all of the animals present in the center, their ailments, assigned doctors, feeding schedule, favorite foods, etc.

   Be thorough: give the schemas and constraints on the schemas. You may use English to describe the relations and constraints.