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

SELECT * FROM R NATURAL JOIN S NATURAL JOIN T WHERE $T.E \le S.D$;

(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 relation has two keys: the aggregate key ABD , and the aggregate key ABE .)	ABD and	ABE.	(That is, the

- 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) $C \to ABD$ $ABCDEF \rightarrow G$ $ABCD \rightarrow E$ $AB \to C$

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

- 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 3NF
- $ABC \rightarrow DEF \qquad D \rightarrow AB \qquad F \rightarrow C$

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

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

- 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) $A \to ABC$ $A \to DC$ $E \to AF$

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

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

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

$$R(\underline{A}\ \underline{B}\ C\ D)$$

$$S(\underline{A}\ E\ F) \qquad \qquad \pi_A(S) \subseteq \pi_A(R)$$

$$T(\underline{A}\ \underline{B}\ G\ H) \qquad \qquad \pi_{AB}(T) \subseteq \pi_{AB}(R)$$

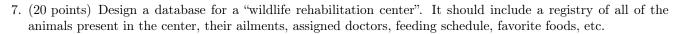
Write the shortest and simplest queries and expressions that you can think of.

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".



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