Full name: _____

CSC336 : John Connor — Midterm

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

1. (5 points) What is the cardinality of $(((B \times B) \backslash (C \times C)) \cap (B \times B)) \cup A$ if

$$A = \{0, 1, 2\} \qquad B = \{3, 4, 5, 6\} \qquad C = \{2, 3, 4\}$$

2. (10 points) List all of the super-keys of the relation $R(A, B, C, D)$ with keys AB and C. (That is, the relation has two keys: the aggregate key AB, and the key C.)

3. (10 points) What is the closure of $\{A, B\}$ with respect to $R(A, B, C, D, E, F, G)$ if R has the following functional dependencies? Show your work!

   (a) $A \to C \quad C \to D \quad D \to B \quad DB \to F$

   (b) $C \to D \quad D \to E \quad E \to F \quad F \to G$

   (c) $A \to G \quad G \to B \quad E \to F \quad B \to C \quad ABC \to G$

   (d) $A \to D \quad DB \to C \quad AC \to F \quad F \to AE$

4. (10 points) For each of the following questions, if the schema $R(A, B, C, D, E)$ is in BCNF or 3NF with respect to the given the functional dependencies, draw a circle around BCNF or 3NF (or both) as appropriate. Show your work!

   (a) BCNF 3NF $A \to BC,\ C \to D,\ E \to D$

   (b) BCNF 3NF $A \to BCE,\ AC \to D$

   (c) BCNF 3NF $A \to BC,\ AC \to D,\ ABC \to E$

   (d) BCNF 3NF $E \to ABCD$

   (e) BCNF 3NF $E \to ABCD,\ D \to A$

5. (15 points) Compute the 3NF for $R(A, B, C, D, E)$ with the following FDs.

   (a) $A \to BC,\ C \to D,\ E \to D$

   (b) $A \to BC,\ E \to BCD$

   (c) $A \to BC,\ C \to DE$

6. (10 points) This question is about how to design databases. Be thorough: give the schemas, constraints, and foreign key relations. You may use English to describe the constraints and foreign key relations.

   (a) Design a database for a library.

   (b) Design a database for a zoo. Some ideas to get you started: What animals does a zoo have? Where are they located? What and when do they eat? Etc.

7. (10 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. **I will deduct points if a natural join is sufficient and you make me read a bunch of conditions, or if you explicitly project every name in the relation.**

GOOD: $R \bowtie T$

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

(a) All attributes from all relations, ignoring relationships.

(b) $R.A, R.B, R.C, R.D, S.E, S.F, T.G, T.H$, where $R.A = S.A,\ R.A = T.A,\ R.B = T.B$ and $S.F < 100$.

(c) The product of R with itself, and with the attributes renamed to `foo, bar, bin, baz`.

The next question use the following relations

student(empl_id, name, bday) course(course_id, name)

enrolment(empl_id, course_id, section, grade) class(course_id, section, semester, lecturer_id)

8. (10 points) Write a SQL query to fetch all of the names of students enrolled in a class with a course name of "CSC336" and a semester of "Fall2018".

9. (10 points) Given the following relations, write a SQL query to create a "report card" for each student. The records should be of the form (student_name, course_name, grade).

10. (10 points) Write the table creation queries for the above relations, along with the obvious foreign key relationships, and a check constraint restricting the "grade" column to be an integer between 0 and 13, inclusive.