Initial: _____

Name _____ RUID _____

CS 198:336 Midterm Exam 2 - Spring 2019
Section 4, 5, 6 (Circle your section)

- Please put your initials on all pages
- Two queries are equivalent if they return the same answer (including duplicates) over all possible database states

Part 1	
Part 2	
Part 3	
Part 4	
Part 5	
Total	

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Part 1: Functional Dependency (35 points)

Question 1.1 Consider the relational schema $R(A, B, C, D)$ and the following set of functional dependencies:

$$S = A \rightarrow B, BC \rightarrow A, D \rightarrow C$$

A functional dependency $X \rightarrow Y$ (e.g., $BD \rightarrow A$) is said to "logically follow" from S if when you compute the closure X^+ ($\{B, D\}^+$ in this case), it contains Y (A in this case).

If $X \rightarrow Y$ does not logically follow from S, then there must be an instance of the relation R which satisfies the dependencies in S, but does not satisfy $X \rightarrow Y$. (* Finding this may take a bit of thinking, and working backward.)

For each of the functional dependencies $X \rightarrow Y$ below show whether it logically follows from S or not. (So if the answer, is "yes", start by computing X^+. If the answer is "no", show the appropriate (*smallest) instance.)

(i) $A \rightarrow C$

(ii) $BD \rightarrow A$

(iii) $CD \rightarrow B$

(iv) $BCD \rightarrow A$

Relational schema $R(A, B, C, D)$ where $S = A \rightarrow B, BC \rightarrow A, D \rightarrow C$

(i) Does $A \rightarrow C$ logically follows from S? If yes, explain your answer. **(5 points)**

(ii) Does $BD \rightarrow A$ logically follows from S? If yes, explain your answer. **(5 points)**

(iii) Does $CD \rightarrow B$ logically follows from S? If yes, explain your answer. **(5 points)**

(iv) Does $BCD \rightarrow A$ logically follows from S? If yes, explain your answer. **(5 points)**

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Question 1.2 Consider a relation $R(A, B, C, D, E)$ satisfying the following dependencies:

$$A \to E, BC \to D, ED \to A$$

(a) List all keys for R. **(5 points)**

LHS	Both	RHS

Columns	Plus Set	Superkey? (Yes/no)	Minimum Superkey? (Yes/no)

List Minimum Superkey(s): _____

(b) Is R in 3NF? Justify your answer. **(4 points)**

(c) R is not in BCNF. Explain why. **(6 points)**

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Part 2: True/False (Totals 15 points)

(1) _____ Assume that you have an E-R schema where relationship `EnrolledIn` relates entities `Student`, `Course` and `Semester` and represents the fact that a student is enrolled in a course for a certain semester (year-term). According to this schema, a student can't enroll for the same course more than once. **(4 points)**

(2) _____ Consider relation `Teaching(ProfId, CrsId, Sem)`, which keeps track of who taught what during a semester (such as `'2008F'`) and assumes that a course is taught during any one term once by a single professor. For this relation, the expression

```
SELECT T.Sem, COUNT(ProfId) FROM Teaching T GROUP BY T.Sem;
```

returns a relation showing how many courses were taught during each semester. **(5 points)**

(3) _____ Given $R(ABCDE)$ with functional dependencies $F = \{AB \rightarrow C, A \rightarrow D, D \rightarrow E, AC \rightarrow B\}$, then ABC is a key. **(6 points)**

Part 3: Convert the following statements to SQL and Datalog (15 points)

Consider a database with the following schema:

```
LIKES(drinker, beer);       /* Key: All columns */
FREQUENTS(drinker, pub);    /* Key: All columns */
SERVES(pub, beer, cost);    /* Key: (pub, beer) */
```

1. Find pubs that serve some beer that Joe likes.

   SQL (5 points):

   Datalog (5 points):

2. Find drinkers who frequent pubs where they can get a drink for less than $3 **(5 points)**

   Datalog:

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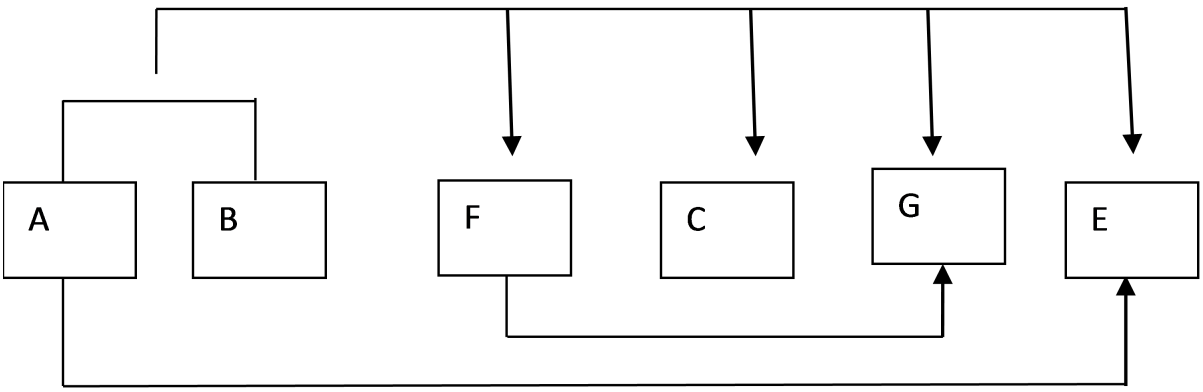
Part 4: Normalization (15 points)

Normalization: Label partial dependency and transitive dependency. Then solve the second normal form and third normal form with different tables and link them back with foreign key:



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PART 5. Integrity Constraints (CHECK, ASSERTION, TRIGGERS) (20 points)

Consider the following relational schema. An employee can work in more than one department; the `pct_time` field of the `Works` relation shows the percentage of time that a given employee works in a given department.

```
Emp(eid: integer, ename: string, age: integer, salary: real)
Works(eid: integer, did: integer, pct_time: integer)
Dept(did: integer, budget: real, managerid: integer)
```

Write SQL integrity constraints (domain, key, foreign key, CHECK constraints, assertions, SQL triggers) to ensure each of the following requirements, considered independently.

1. Employees must make a minimum salary of $1000. **(6 points)**

```
CREATE TABLE Emp (
```

2. Every manager must also be an employee. **(7 points)** (Fill in underline)

```
CREATE ASSERTION ManagerIsEmployee

CHECK ((SELECT ________ (*)

FROM ________ AS ________

WHERE ________.managerid ________ IN

(SELECT ________ FROM ________)) = 0)
```

3. Use Triggers to monitor if the you try to modify the salary to employee table, and if old salary is less than new salary, put the information into the `Warning` table **(7 points)** (Fill in underline)

```
CREATE TRIGGER dynamicSalaryCheck ________  -- (pick one: either BEFORE or AFTER)

________ -- (pick one: INSERT, UPDATE, DELETE)

OF salary ON Employee REFERENCING

OLD ROW AS oldTuple

NEW ROW AS newTuple

FOR EACH ROW

WHEN (_____.salary > _____.salary)

INSERT INTO Warning (empID, oldSal, newSal)

VALUES (________, ________, ________);
```