**Midterm Exam**

EECS 3421

Winter 2018

First Name:

Last Name:

Student Number:

**Question 1** (4 points)

Your ﬁrst task is to organize the information about all the airplanes stationed and maintained at the airport. The relevant information is as follows:

* Every airplane has a registration number, and each airplane is of a speciﬁc model.
* The airport accommodates a number of airplane models, and each model is identiﬁed by a model number (e.g., DC-10) and has a capacity and a weight.
* A number of technicians work at the airport. You need to store the name, SSN, address, phone number, and salary of each technician.
* Each technician is an expert on one or more plane model(s), and his or her expertise may overlap with that of other technicians. This information about technicians must also be recorded.
* Traﬃc controllers must have an annual medical examination. For each traﬃc controller, you must store the date of the most recent exam.
* All airport employees (including technicians) belong to a union. You must store the union membership number of each employee. You can assume that each employee is uniquely identiﬁed by a social security number.
* The airport has a number of tests that are used periodically to ensure that air-planes are still airworthy. Each test has a Federal Aviation Administration (FAA) test number, a name, and a maximum possible score.
* The FAA requires the airport to keep track of each time a given airplane is tested by a given technician using a given test. For each testing event, the information needed is the date, the number of hours the technician spent doing the test, and the score the airplane received on the test.

Draw an ER diagram for the airport database. Be sure to indicate the various attributes of each entity and relationship set; also specify keys and constraints. 

**Question 2.** (6 pts.) Using (some of) the relations:

Consider the following four relations to store data about animals in a zoo:

Animals (idNumber, type, cageNumber)

Cages (cageNumber, maxAnimals)

TypeKeepers (name, type)

CageKeepers (name, cageNumber)

idNumber is a key for Animals, and cageNumber is a key for Cages. Cages.maxAnimals species the maximum number of animals allowed in that cage. TypeKeepers lists people responsible for caring for a particular type of animal, while CageKeepers lists people responsible for caring for a certain cage. For each of these two, both attributes form the key; i.e. it is possible for the same person to care for multiple types/cages, and it is possible for the same type/cage to be cared for by several people.

Consider the following sequence of relational algebra statements:

Temp1 := Animals ⋈ CageKeepers

Temp2 := Animals ⋈ TypeKeepers

FinalAnswer := Temp1 Ո Temp2

1. Given the following sets of data for each of the relations, show (in the space on the next page) the relation that will be stored into FinalAnswer (show the schema and all the tuples that will be in the relation).



**Answer:**

**idNumber type cageNumber name**

1 zebra 10 Ann

3 monkey 10 bob

4 kangaroo 30 chris

6 monkey 40 bob

(b) State brieflyy what the query from (a) is asking.

The query in part (a) asks for all animals (their id, type, and cageNumber) such that the animal has the same person as both its type keeper and its cage keeper (include that person's name in the tuple for the animal in the result).

Notes: Many people answered this along the lines of "All people who..." but this is not quite correct -- a query asking for all people that fulfill a certain condition would have each person appearing at most once in the result. This query could have the same person appear many times, but each animal could only appear at most once. Thus it was looking for all animals that fulfilled a certain condition.

**Question 3**: (9 points) Consider the relation schema R (A; B; C; D; E ; F) with functional dependencies:

 AC ->B, BD -> F , and F -> CE.

a) (3 pts.) Find all the keys of R.

A, C, D}, {A, D, F}, {A, B, D}

Basically you have to compute the closure of all subsets of attributes testing which ones are minimal keys. You can take some shortcuts however. Note every key must contain A and D since neither of these attributes appear on the right side of any FDs. Working incrementally starting with {A, D} yields the three keys above.

b) (4 pts.) Choose one FD of R that violates BCNF (and state which). Decompose R into two relations R1, and R2, using this FD.

FD:

R1 =

R2 =

Is R1 in BCNF?

Is R2?

AC->B yields R1(A, B, C) [Yes] and R2(A, C, D, E, F) [No]

BD->F yields R1(B, D, F) [Yes] and R2(A, B, C, D, E) [No]

F->CE yields R1(C, E, F) [Yes] and R2(A, B, D, F) [No]

c) (2 pts.) Suppose we project R onto S(A; C; D; E). Give one nontrivial FD that holds in S.

ACD->E

**All remaining questions (1 point each) are multiple choice. Only one answer is correct.**

**Question 4.** Which of the following statements about E/R models is/are correct?

I. Many-to-many relationships cannot be represented in E/R-diagrams

II. Relationship sets can have attributes of their own.

III. All many-to-one relationships are represented by a relationship between a weak and a non-weak entity set.

1. II only.
2. III only.
3. II and III only.
4. I and II only.

**Question 5.** Consider relation R(A,B,C,D) with the only FD: B→CD. The minimal basis for the relation is:

1. B→CD
2. B→D, B→C
3. B→ABCD
4. The relation with the given FD has no minimal basis

**Question 6**. For the relation and FD in Question 5, the decomposition into 3NF is:

1. AB, BC, BD
2. BCD, AB
3. AB, AC, AD
4. The relation is already in 3NF, hence no decomposition is needed

**Question 7.** Consider relation R(A,B,C,D,E) with FDs

            A-> B, AB->CD, D->ABCE

        Which of the following are keys of the relation R

        I A

        II AB

        III CD

a)    I only.

b)   I and II only.

c)    II, and III only.

d)    I, II, and III.

A

**Question 8.** Suppose we are told that  R(A, B, C, D) is in BCNF, and that three out of the four FDs (a)-(d) listed below hold for R.  Choose the FD that R doesn’t satisfy.

a)      A -> BCD

b)      BC -> A

c)     CD -> B

d)      D -> C

d

**Question 9**: Consider the following E/R diagram: 

Below are three possible relationship sets for this E/R diagram:



You may assume that different symbols stand for different values. Which of the above could not be the relationship set for the E/R diagram?

(a) I only

(b) I and II only

(c) II only

(d) I, II and III

A

The following three questions are based on the E􀀀R diagram below􀀁 

**Question 10:** If entity set A currently has 100 entities, which of the following could be the number of B entities?

I 1

II 100

II 200

A I or II only

B II or III only

C II only

D I or II or III

D

**Question 11:** If we convert the E/R diagram to relations in the standard way described in the text, which set of attributes would *not* appear as the schema of some relation?

1. (b, c, e)
2. (a, b)
3. (a, b, c, d)
4. (c, f)

B

**Question 12:** In the following problem, assume the schemas are R(A B) and S(B C)

Q1: σA=1 (R ⋈ S)

Q2: (σA=1 (R)) ⋈ S

1. Q1 and Q2 produce the same answer.
2. The answer to Q1 is always contained in the answer to Q2.
3. The answer to Q2 is always contained in the answer to Q1.
4. Q1 and Q2 produce different answers.

A

**Question 13:** In the following relational algebra expressions, R and S have the same schema, which includes attribute a, but the schemas are otherwise arbitrary.

Q1: πa(R) - πa(S)

Q2: πa (R - S)

1. Q1 and Q2 produce the same answer.
2. The answer to Q1 is always contained in the answer to Q2.
3. The answer to Q2 is always contained in the answer to Q1.
4. Q1 and Q2 produce different answers.

B