Midterm Exam #1 (Version A)
CS 122A
Spring 2019

Max. Points: 100
(Please read the instructions carefully)

Instructions:
- The total time for the exam is 50 minutes; be sure to budget your time accordingly.
- The exam is closed book and closed notes but “open cheat sheet”.
- Read each question first, in its entirety, and then carefully answer each part of the question.
- If you don’t understand something, ask one of the exam proctors for clarification.
- If you still find ambiguities in a question, note the interpretation you are taking.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>TOPIC</th>
<th>POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Relational Design Theory</td>
<td>25</td>
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<td>Modeling Terms</td>
<td>10</td>
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<td>3</td>
<td>E-R Modeling</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>E-R to Relational Translation</td>
<td>35</td>
</tr>
<tr>
<td>TOTAL</td>
<td>All</td>
<td>100</td>
</tr>
</tbody>
</table>
Question 1: Relational Design Theory (25 points)

Answer each of the following questions about relational DB design and functional dependencies:

(7 pts) Consider a relation S (a, b, c, d, e) with FDs a → b, b → c, c,d → e.

a. List the candidate keys for S: (a,d)

b. Circle the highest normal form that S satisfies: 1NF 2NF 3NF BCNF

c. Compute the attribute closure (b+) of the attribute b: b+ = {b,c}

(10 pts) Assuming that a (possibly different) table S (a, b, c, d, e) currently contains the following data values, answer the following questions about S’s set of functional dependencies.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gibson</td>
<td>6</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Yamaha</td>
<td>80</td>
<td>950</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Gibson</td>
<td>6</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Selmer</td>
<td>23</td>
<td>375</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ludwig</td>
<td>5</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Gibson</td>
<td>5</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Fender</td>
<td>4</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

a. Is it possible that this is the same table S described above? YES NO

b. Does the functional dependency d → e currently hold in S? YES NO

c. Does the functional dependency b,c → d currently hold in S? YES NO

d. Based on seeing S’s content, can we infer that a is a candidate key? YES NO

e. Identify a tuple in S that could be deleted to enforce the functional dependency c → d (i.e., if this tuple were deleted, the functional dependency would hold in the resulting version of S):

<table>
<thead>
<tr>
<th></th>
<th>Gibson</th>
<th>Bass</th>
<th>5</th>
<th>200</th>
</tr>
</thead>
</table>

(8 pts) Consider a (possibly still different!) table S (a, b, c, d, e) with FDs a,b → e,d, d → c.

a. Circle the highest normal form that S satisfies: 1NF 2NF 3NF BCNF

b. Normalize S into a dependency-preserving, lossless-join 3NF design (S1, S2, …). List the resulting tables and their corresponding candidate keys:

S1:(a,b,d,e) CK: (a,b)  
S2:(d,c) CK:d

c. Is your 3NF design also in BCNF? YES NO
**Question 2: Modeling Terms (10 points)**

(10 pts) You’ve been hired by the Research Division of UCI as an IT intern. On your first day on the job, you are told the following about the data for a project management database that they want to develop:

- Professors have a unique social security number, a person name (first, middle, last), an e-mail address, a rank, and one or more research specialties.
- Projects have a unique project number, a unique project name, a sponsor name (e.g., NIH), a start date, possibly an end date, and a budget.
- Graduate students have a unique social security number, a person name (first, middle, last), an e-mail address, an age, and a degree program (e.g., MS or PhD).
- Each project is managed by exactly one professor (the project’s principal investigator).
- Each project is worked on by zero or more other professors (the project’s co-investigators).
- Professors can manage and/or work on multiple projects.
- Each project is assisted by zero or more graduate students (known as its research assistants).
- When a graduate student assists with a project, his/her assistance work on that particular project is always supervised by some professor. Graduate students may assist multiple projects, in which case he/she will have a (potentially different) supervisor for each one.
- Departments have a department number, a department name, and a main office.
- Departments have a professor (known as the chair) who runs the department.
- Professors are appointed as members of one or more departments, and for each department in which they hold an appointment, there is a percent time associated with the appointment.

Match each of the modeling constructs in the left column below with their best-matching feature (drawn from the description above) in a good E-R design in the right column below. Indicate your answer by writing the relevant description feature in the blank to the left of each modeling construct. (Note: You are permitted to use each feature *ONLY ONCE!* Also, you may find it bit easier to go down the list of features looking for constructs rather than going down the list of constructs looking for features.)

<table>
<thead>
<tr>
<th>Modeling construct</th>
<th>Description feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>research specialty</td>
<td>research specialty</td>
</tr>
<tr>
<td>email</td>
<td>social security number</td>
</tr>
<tr>
<td>age</td>
<td>student age</td>
</tr>
<tr>
<td>percent time</td>
<td>percent time</td>
</tr>
<tr>
<td>person name</td>
<td>person name</td>
</tr>
<tr>
<td>assists</td>
<td>assists</td>
</tr>
<tr>
<td>dept</td>
<td>department</td>
</tr>
<tr>
<td>project end time</td>
<td>project end date</td>
</tr>
<tr>
<td>project number, project name</td>
<td>project number, project name</td>
</tr>
<tr>
<td>ssn</td>
<td>e-mail address</td>
</tr>
</tbody>
</table>
Question 3: E-R Modeling (30 points)

(30 pts) Based only on the E-R model pictured at the bottom of this page, indicate whether each of the following statements are true (T) or false (F) by writing the appropriate letter in the space to the left of the statement.

- F  A student can be co-advised by two or more professors.
- T  A paper may contain no figures.
- F  A given figure may appear in two or more papers.
- T  It is possible to have two papers with the same title.
- F  A figure can be uniquely identified by its figure number (figno).
- F  It is possible for a person to have both a rank and a gpa.
- F  Every paper must have a student among its authors.
- T  Every person must be a student or a professor.
- T  A student may have two phone numbers.
- F  A professor must author at least one paper (“publish or perish”, as they say).
- T  A figure must always be contained in some paper.
- T  For a given paper that they author, a person has a unique author number (authno).
- T  A professor may advise multiple students.
- F  Each paper must have multiple authors.
- T  A given paper or may not have a length.
Question 4: E-R to Relational Translation (35 points)

(35 pts) Translate the following E-R schema into an appropriate set of SQL tables. As usual, avoid using more tables than necessary, and be sure that your translated design – expressed as CREATE TABLE statements in SQL – includes any/all appropriate (i) primary keys, (ii) unique keys, (iii) NOT NULL constraints, (iv) FOREIGN KEY constraints, and (v) ON DELETE options. We’ve started the answer for you below, providing the full answer for Paper and part of the answer for Figure. Finish filling in the details of Figure in the space on the right, adding any missing attributes and/or constraints, and then finish the job by adding any/all additional CREATE TABLE statements in the space on the left below. **Note:** Your answer should be able to fit on this page. (If the space on this page is not enough, you may use the blank page at the end of this exam to continue your answer – but that should not be necessary.)

```
CREATE TABLE Person (  
  name VARCHAR(80) NOT NULL,  
age INT,  
ssno CHAR(9),  
PRIMARY KEY (ssno)
);

CREATE TABLE Author (  
  ssno CHAR(9),  
doi VARCHAR(60),  
authno INT NOT NULL,  
PRIMARY KEY (ssno, doi),  
FOREIGN KEY (ssno)  
  REFERENCES Person (ssno)  
  ON DELETE CASCADE,  
FOREIGN KEY (doi)  
  REFERENCES Paper (doi)  
  ON DELETE CASCADE
);

CREATE TABLE Paper (  
  title VARCHAR(100) NOT NULL,  
do VARCHAR(60),  
date DATE NOT NULL,  
length INT,  
PRIMARY KEY (doi)
);

CREATE TABLE Figure (  
  caption VARCHAR(100),  
figno INT NOT NULL,  
paper doi VARCHAR(60),  
PRIMARY KEY (paper doi, figno),  
FOREIGN KEY (paper doi)  
  REFERENCES Paper (doi)  
  ON DELETE CASCADE
);```