Midterm Exam #1 (Version A)
CS 122A
Spring 2018

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.

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<th>POINTS</th>
<th>SCORE</th>
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<td>TOTAL</td>
<td>All</td>
<td>100</td>
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Question 1: Modeling Terms (10 points)

(10 pts) You’ve just been hired as a consultant for Orange County’s best TV show production company, ABCD! They are filming a new TV series called Friday Nights with Databases, and they need your help to set up a database for their business. ABCD also has other shows and is hoping to use your new database for all of their show management. Here’s what their IT manager has to say:

- Each show has a title and a first_air_date (together as a combination that uniquely identify it) and a show_description that includes both a show_time and a genre.
- Each staff member has a unique staff_id, a name, and a home address that includes a street address, city, state, and zipcode.
- Each staff member can be either a cast member or a producer. Cast members star in shows, while producers work on show productions. Each producer has a specialty. Each cast member has an hourly_rate and a monthly_salary calculated from his/her hourly_rate.
- Whenever ABCD decides to keep the Friday Nights with Databases show on the air, a new season is scheduled. A season is associated with a particular show. Each season of a show has a cost, a season_number, and a duration of the season. There are multiple seasons for a successful show (e.g., this might be the 7th season of a show).
- Each season of a show includes one or more cast members, each of whom contributes a certain number of hours to the season in which his/her dialogue is present according to the story line.
- The ABCD production company profits from advertising. They have multiple clients around the globe. Each client has a unique client_id, a business name, a business type, and a business address.
- When a client wants to advertise their business on a TV show, a contract is created among a producer, the client, and a particular show. Each contract states a duration, cost_per_minute, and number of occurrences.

Match each of the modeling constructs in the left column below with their best-matching feature (drawn from the description above) in the right column below. *(NOTE: You should use each feature ONLY ONCE, and you might find it quicker to go down the list of features looking for constructs rather than going down the list of constructs looking for features.)*

** Alternative solution will be accepted ONLY if they are used once. **

<table>
<thead>
<tr>
<th>Modeling construct</th>
<th>Alternatives</th>
<th>Description feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>producer</td>
<td>Entity</td>
<td>cost_per_minute</td>
</tr>
<tr>
<td>contract</td>
<td>Ternary relationship</td>
<td>business_address</td>
</tr>
<tr>
<td>monthly_salary</td>
<td>Derived attribute</td>
<td>monthly_salary</td>
</tr>
<tr>
<td>staff_name</td>
<td>Inherited attribute</td>
<td>season_number</td>
</tr>
<tr>
<td>business_address</td>
<td>Atomic attribute</td>
<td>cost_per_minute, staff_name</td>
</tr>
<tr>
<td>cost_per_minute</td>
<td>Relationship attribute</td>
<td>title, first_air_date</td>
</tr>
<tr>
<td>show_description</td>
<td>Composite attribute</td>
<td>producer</td>
</tr>
<tr>
<td>season_number</td>
<td>Partial key</td>
<td>staff_name</td>
</tr>
<tr>
<td>title, first_air_date</td>
<td>Candidate key</td>
<td>show_description</td>
</tr>
<tr>
<td>client_id, business_name</td>
<td>Super key</td>
<td>title, first_air_date</td>
</tr>
</tbody>
</table>

Score ________
Question 2: E-R Modeling (30 points)

(30 pts) Based only on the E-R model given below, indicate whether each of the statements that follow it are true (T) or false (F) by writing the appropriate letter in the space to the left of the statement.

__ F__  A coach could have been trained by multiple coaches.
__ F__  Each club has to support at least one team.
__ T__  Not every athlete needs to be coach or a player.
__ F__  An athlete that does not have at least one interest cannot be considered as a player.
__ F__  Only those teams that participate in a league need a club as their sponsor.
__ F__  Each coach has to train at least one coach.
__ F__  A coach can be his own trainer only if he is also a player.
__ T__  It is possible for an athlete to have neither an interest list nor a rating.
__ F__  In a given league, a coach can participate with two teams that have the same name (tname) only in different years.
__ F__  The name (tname) of a team combined with league name (lname) will uniquely identify the team in the database overall.
__ F__  A team has to use the same coach in order to participate in multiple leagues.
__ F__  Each player has to be trained by at least one coach.
__ F__  It is possible to have two teams with the same name in a given club only if they are for different sports.
__ T__  A coach can be trained by a coach who has the same rating as their rating.
__ F__  The sport of a team can be derived from its name (tname) and its club name.

Score ________
Question 3: 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 Sculptor and a part of the answer for Sculpture. Finish filling in the details of Sculpture, adding any missing attributes and/or constraints, and then finish the job by adding any additional CREATE TABLE statements. Note: Try hard to fit your answer in the space below. As a last resort, there is a blank page at the end of this exam that you can use in the unlikely event of an overflow.

CREATE TABLE Sculptor  
(name VARCHAR(40),
birthdate Date,
nationality VARCHAR(35),
PRIMARY KEY(name))
);

CREATE TABLE Sculpture  
sname VARCHAR(20),
location VARCHAR(30),
material VARCHAR(30),
price DECIMAL(8,2),
sculptor_name VARCHAR(40),
buyyer_name VARCHAR(40),
date Date,
Primary Key(sname, sculptor_name),
Foreign Key(sculptor_name) References Sculptor(name) ON DELETE CASCADE,
Foreign Key(buyyer_name) References Sculptor(name)
);

Score ________
Create Table Subject(
    context    VARCHAR(20),
    sculptor_name  VARCHAR(40),
    sculpture_name  VARCHAR(40),
    Primary Key (context,sculptor_name,sculpture_name),
    Foreign Key(sculptor_name,sculpture_name) References Sculpture(sname,sculptor_name) ON DELETE CASCADE
);

Create Table Inspire(
    inspirer   VARCHAR(20),
    inspiree   VARCHAR(20),
    Primary Key(inspirer,inspiree),
    Foreign Key(inspirer) References Sculptor(name),
    Foreign Key(inspiree) References Sculptor(name)
);

Question 4: Relational Design Theory (25 points)

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

(5 pts) Consider a relation \( R \) \((a, b, c, d, e)\) with FDs: \( b \rightarrow a \), \( b \rightarrow c \), \( ac \rightarrow d \), \( c \rightarrow e \).

a. Compute the attribute closure \((c^+)\) of the attribute \( c \): \( c,e \)

b. Circle the highest normal form that \( R \) satisfies: \( 1NF \) \( 2NF \) \( 3NF \) \( BCNF \)

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

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1928</td>
<td>Mickey</td>
<td>Mouse</td>
<td>Burbank</td>
<td>M</td>
</tr>
<tr>
<td>1934</td>
<td>Donald</td>
<td>Duck</td>
<td>Duckburg</td>
<td>M</td>
</tr>
<tr>
<td>1973</td>
<td>Robin</td>
<td>Hood</td>
<td>Sherwood</td>
<td>M</td>
</tr>
<tr>
<td>1928</td>
<td>Minnie</td>
<td>Mouse</td>
<td>Burbank</td>
<td>F</td>
</tr>
<tr>
<td>1926</td>
<td>Winnie</td>
<td>DaPooh</td>
<td>AcreWood</td>
<td>M</td>
</tr>
<tr>
<td>1964</td>
<td>Mary</td>
<td>Poppins</td>
<td>London</td>
<td>F</td>
</tr>
</tbody>
</table>

a. Does the functional dependency \( a \rightarrow b \) currently hold in \( R \)?  
   YES  NO

b. Does the functional dependency \( (a,b) \rightarrow c \) currently hold in \( R \)?  
   YES  NO

c. Does the functional dependency \( c \rightarrow d \) currently hold in \( R \)?  
   YES  NO

Score ________
d. Does the functional dependency \((a, c) \rightarrow e\) currently hold in \(R\)?  
   YES  NO

e. Does the functional dependency \(c \rightarrow b\) currently hold in \(R\)?  
   YES  NO

(10 pts) Consider a table \(R\) \((a, b, c, d, e, f, g)\) with FDs: \(a \rightarrow c,\ a \rightarrow b,\ f \rightarrow e,\ d \rightarrow g\).

a. List the candidate key(s) for \(R\): \(adf\)

b. Circle the highest normal form that \(R\) satisfies:  
   1NF  2NF  3NF  BCNF

c. Normalize \(R\) into a lossless-join BCNF design \((R_1, R_2, \ldots)\):
   
   \[
   \begin{align*}
   R_1 & (a, b, c), \\
   R_2 & (f, c), \\
   R_3 & (d, g), \\
   R_4 & (a, d, f)
   \end{align*}
   \]
   Alternative: 
   
   \[
   \begin{align*}
   R_1 & (a, b), R_2(a, c), \\
   R_3 & (f, c), \\
   R_4 & (d, g), \\
   R_5 & (a, d, f)
   \end{align*}
   \]

d. Is your BCNF design dependency-preserving?  
   YES  NO

Score ________