Midterm Exam #1 (Version C)
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>SCORE</th>
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Question 1: 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 teacher cannot be advised by a teacher who has the same rank as their rank.

**F** The name (tname) of a team combined with olympiad name (Iname) will uniquely identify the team in the database overall.

**T** It is possible for a scientist to have neither an interest list nor a rank.

**F** A teacher cannot be his own advisor if he is also a student.

**F** Each club has to support at least one team.

**F** The field of a team can be derived from its name (tname) and its club name.

**F** It is possible to have two teams with the same name in a given club only if they are for different fields.

**T** Not every scientist needs to be teacher or a student.

**F** A scientist that does not have at least one interest cannot be considered as a student.

**F** Only those teams that participate in an olympiad need a club as their sponsor.

**F** Each student has to be advised by at least one teacher.

**F** A teacher could have been advised by multiple teachers.

**F** In a given olympiad, a teacher can participate with two teams that have the same name (tname) only in different years.

**T** Each teacher can advise one or more teachers.

**F** A team has to use the same teacher in order to participate in multiple olympiads.

Score ________
**Question 2: Modeling Terms (10 points)**

(10 pts) You’ve just been hired as a consultant for Orange County’s best TV show production company, *A&B!* They are filming a new TV series called *Weekends with Databases*, and they need your help to set up a database for their business. *A&B* 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.
- The *A&B* 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.
- Whenever *A&B* decides to keep the *Weekends 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.

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. Indicate your answer by writing the relevant description feature in the blank to the left of each modeling construct. *(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.)*

<table>
<thead>
<tr>
<th>Modeling construct</th>
<th>Alternatives</th>
<th>Description feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>monthly_salary</td>
<td>Derived attribute</td>
<td>producer</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>monthly_salary</td>
</tr>
<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>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 3: 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.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>Peter</td>
<td>Parker</td>
<td>New York</td>
<td>M</td>
</tr>
<tr>
<td>1934</td>
<td>Tony</td>
<td>Stark</td>
<td>Massachusetts</td>
<td>M</td>
</tr>
<tr>
<td>1941</td>
<td>Steve</td>
<td>Rogers</td>
<td>Texas</td>
<td>M</td>
</tr>
<tr>
<td>1962</td>
<td>May</td>
<td>Parker</td>
<td>New York</td>
<td>F</td>
</tr>
<tr>
<td>1926</td>
<td>Wade</td>
<td>Wilson</td>
<td>Kansas</td>
<td>M</td>
</tr>
<tr>
<td>1964</td>
<td>Susan</td>
<td>Storm</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

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 $R (t, u, v, w, x, y, z)$ with FDs: $t \rightarrow v$, $t \rightarrow u$, $y \rightarrow x$, $w \rightarrow z$.

a. List the candidate key(s) for $R$: twy

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

c. Normalize $R$ into a lossless-join BCNF design $(R1, R2, \ldots)$:
   
   R1 ($t$, $u$, $v$)  
   R2 ($y$, $x$),  
   R3 ($w$, $z$),  
   R4 ($t$, $w$, $y$)
   
   Alternative: R1 ($t$, $u$), R2 ($t$, $v$), R3 ($y$, $x$), R4 ($w$, $z$), R5 ($t$, $w$, $y$)

Is your BCNF design dependency-preserving? YES NO

Score ________
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 Artist and a part of the answer for Handcraft. Finish filling in the details of Handcraft, adding any missing attributes and/or constraints, and then finish the 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 Artist (  
    name VARCHAR(40),  
    birthdate Date,  
    email VARCHAR(50),  
    PRIMARY KEY(name)  
);

CREATE TABLE Handcraft (  
    hname VARCHAR(20),  
    id VARCHAR(10),  
    category VARCHAR(30),  
    price DECIMAL(8,2),  
    artist_name VARCHAR(40),  
    orderer VARCHAR(40),  
    date DATETIME,  
    Primary Key(artist_name,hname,id),  
    Foreign Key(artist_name) References Artist(name) ON DELETE CASCADE,  
    Foreign Key (orderer) References Artist(name)  
);

CREATE TABLE Material (  
    artist_name VARCHAR(40),  
)
```

Score ________
```sql
CREATE TABLE Handcraft(
    artist_name VARCHAR(20),
    handcraft_name VARCHAR(20),
    id VARCHAR(10),
    material_type VARCHAR(30),
    PRIMARY KEY (artist_name, handcraft_name, id, material_type),
    FOREIGN KEY (artist_name, handcraft_name, id) REFERENCES Handcraft(artist_name, handcraft_name, id)
);

CREATE TABLE Teach(
    teacher VARCHAR(40),
    student VARCHAR(40),
    PRIMARY KEY (teacher, student),
    FOREIGN KEY (teacher) REFERENCES Artist(name),
    FOREIGN KEY (student) REFERENCES Artist(name)
);
```

Score ________