CS 365: Database Systems
Spring 2023
Midterm Exam
Don't Dream, It's Over

Instructions: Use any white space (including the backs of the pages) available to write in your answers. Make sure that you indicate the problem number for each of the answers.

The exam is closed-book, closed-notes with a single cheat sheet allowed.

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Problem:	1	2	3	4	5	6	Total
Score:	8	15	5	9	5	8	50
Out Of:	10	20	20	10	5	10	75

66.67%

Problem 1	Score	Out of
1.a	3	3
1.b	0	2
1.c	1	1
1.d	4	4
Total:	8	10

Problem 2	Score	Out of
2.a	8	10
2.b	3	3
2.c	2.5	4
2.d	1.5	3
Total:	15	20

Problem 3	Score	Out of
3.a	5	5
3.b	0	5
3.c	0	5
3.d	0	5
Total:	5	20

Problem 1 *[10 pts]*

Quick hits.

(a) **[3 pts]** List the names of all course datasets.

STUDENTS, INN, MARATHON, WINE, KAZTENJAMMER, CSU, BAKERY, AIRLINES, CARS

3

(b) **[2 pts]** Table R has a primary key A and contains 17,000 tuples. Table S has a primary key B and an attribute C, which is a foreign key referencing R. Table S contains 3,457 tuples. How many tuples will $R \bowtie_{R.A=S.C} S$ contain?

17,000 x 3457 tuples

0/2

3457
b/c join returns all rows R where the value of the A column is equal to the value of C column in S.

(c) **[1 pts]** Give an example of a situation when the SQL command DROP TABLE Students; fails (assuming table Students exists in the database).

An example where DROP TABLE Students fails would be when another table has a foreign key that references an attribute in the Students table. The table Student cannot be dropped since another table relies on it.

1

(d) [4 pts] Consider the following table, describing a list of movie ratings given to various movies by users of a web site:

```
CREATE TABLE Ratings (
  UserID    CHAR(20),     -- Id of the user who provided the rating
  Movie     CHAR(128),    -- Title of the movie
  ReleaseYear    INT,     -- Year of the release of the movie
  Studio    CHAR(20),     -- Studio that released the movie
  Genre     CHAR(20),     -- Genre of the movie
  RatingDate    DATE,     -- Date of the rating
  Rating        Float,    -- Rating of the movie on a -10 to +10 scale
  SimpleRating  INT);     -- Rating of the movie on a "Hated", "Neutral", "Liked" scale
```

A row in this table represents one rating that a user gave to a specific movie at a specific point in time. Let's assume that there can be different movies with the same title (it has happened in the past, e.g., in case of remakes, or movies made in different countries). Let us also assume that a user can give multiple ratings to a movie (as their appreciation for the movie evolves).

Propose one candidate key for this table.

Also, explain why `(UserID, RatingDate, Rating)` is not a valid candidate key.

✓

1) Candidate Key: (UserID, Movie, Studio, Release Year, Rating Date)
   ↳ assumes that users can rate 2 different movies same date, so cannot make multiple ratings for same movie on a single date.

2) (UserID, RatingDate, Rating) is not a valid candidate key because then users cannot give 2 different movies the same rating on the same date.

4

Problem 2 ***[20 pts]*** *(Feel free to pull this page out of the exam) The following database records (partially), a small part of my music collection, that currently resides in my office. The description is broken into three tables, with obvious meanings:* Musicians, CDs *and* Songs.

Musicians (M)

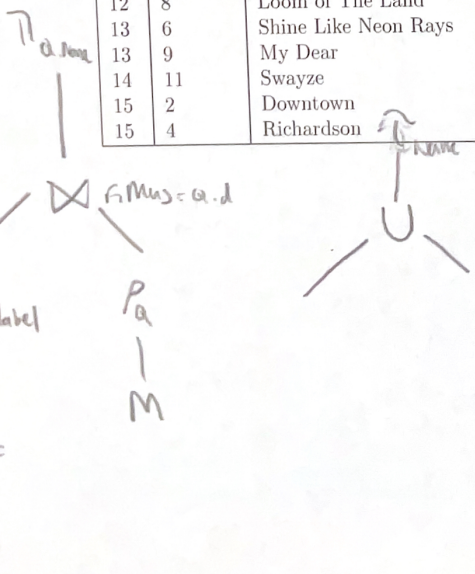
ID	Name	Country
1	Gong	France
2	Mark Knopfler	UK
3	Aquarium	Russia
4	Django Reinhart	France
5	Peter Hammill	UK
6	Tom Waits	USA
7	Crowded House	New Zealand
8	Momus	UK
9	Nick Cave	UK
10	Katzenjammer	Norway
11	Diego's Umbrella	USA

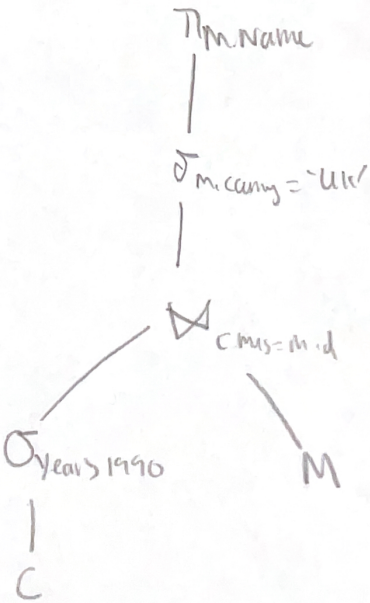
CDs (C)

ID	Musician	Title	Year	Label
1	1	Angel's Egg	~~1973~~	Carol
2	2	Metroland	1998	Warner
3	3	Ichtyology	~~1984~~	SoLyd
4	4	Django's Guitar	~~1955~~	Angel
5	5	In Camera	~~1973~~	Carol
6	5	Nadir's Big Chance	~~1975~~	Carol
7	5	The Silent Corner	~~1971~~	Carol
8	6	Blood Money	2002	Anti
9	7	Together Alone	1993	Capitol
10	8	Folktronic	2000	HRH
11	8	Ultraconformist	1992	Monde
12	9	Henry's Dream	1992	Mute
13	10	Rockland	2016	Propeller
14	11	Double Panther	2009	9th Str. Opus
15	12	Proper Cowboy	2012	9th Str. Opus

Songs (S)

CD	TrackNo	Title	Duration
1	3	Castle in The Clouds	1:09
1	6	Selene	3:38
3	2	Fish	3:30
4	4	Tea For Two	3:17
6	6	Pompeii	3:43
6	7	Shingle	3:26
6	8	Airport	4:01
5	2	The Submariner	5:12
7	7	A Louse is Not a Home	12:13
10	6	Finnegan, the Folk Hero	3:19
9	8	Private Universe	3:30
9	10	Distant Sun	3:45
12	2	I Had a Dream, Joe	5:12
12	8	Loom of The Land	4:21
13	6	Shine Like Neon Rays	4:54
13	9	My Dear	3:05
14	11	Swayze	2:43
15	2	Downtown	3:40
15	4	Richardson	3:23





(a) **[10 pts]** Write SQL commands to create all three tables. (Make sure your SQL commands include ALL necessary information).

```
CREATE TABLE Musicians {
    Id INT PRIMARY KEY,
    Name CHAR(20),
    County CHAR(20)
}

CREATE TABLE CD {
    Id INT PRIMARY KEY,
    Musician INT,
    Title CHAR(20),
    Year CHAR(20),
    Label CHAR(20)
    UNIQUE (Musician, Title),
    FOREIGN KEY Musician REFERENCES Musicians(Id)
}

CREATE TABLE Songs {
    CD INT PRIMARY KEY,
    TRACKN. INT,
    Title CHAR(20),
    Duration TIME,
    UNIQUE (TrackN., Title),
    FOREIGN KEY CD REFERENCES CD(Id)
}
```

→ would mean each CD has only one song.

8/10

→ Pk → PRIMARY KEY (TrackNo, Title)

(b) [3 pts] Write a SQL command that adds to the Songs table, the information that the song titled "Again" with the duration of 4 minutes and 7 seconds is the fourth song on Peter Hammill's In Camera album. If you can, please use the appropriate date-time formatting syntax for this SQL command.

```
Insert into Songs
  Values (5, 4, 'Again', 00:00:04:07)
```

3

(c) [4 pts] Write SQL commands that add two attributes to the Songs table: for the author of the music, and one for the author of the lyrics. Write a SQL command to set the author of both music and lyrics for the song Airport to be Hammill.

```
ALTER Table Songs
  ADD MusicAuthor CHAR(20),
  ADD LyricsAuthor CHAR(20)

UPDATE Songs
  SET MusicAuthor = 'Hammill' and LyricAuthor = 'Hammill'
WHERE
```

~~3~~ 2.5/4

(d) [3 pts] Write a single SQL statement that keeps in the CDs table only the information about (a) albums released after 2005, (b) albums released on Carol before 1974, and (c) album titled Blood Money. All other rows shall be removed.

```
DELETE From CD
  WHERE (NOT CD(CD).Year > 2005)
    ∧ (NOT CD(CD).Year < 1974)
    ∧ (NOT CD(CD).Title 'Blood Money'
```

1.5/3

Problem 3 *[20 pts]*

Consider the database from Problem 2.

Write the following queries in ***relational algebra.***

You can use M,C,S as the table names, and $\rho_{M1}(M)$, $\rho_{C1}(C)$, etc., if you are doing a self-join. If you need to perform comparisons on the Duration attribute, feel free to treat the values as numbers.

(a) **[5 pts]** Find all songs from albums released in 1973. Report the Title of the song and the title of the album.

$\Pi_{S.Title, C.Title}\left(\sigma_{C.Year=1973}(C) \bowtie_{C.Id=CD} S\right)$

5

(b) **[5 pts]** Find all musicians that released multiple albums in 1970s. Report the name of the musician.

$\sigma_{C.Year \geq 1970 \wedge C.Year < 1980}$? 0/5

(c) **[5 pts]** For each song that is longer than `Shingle`, report its title, the year it was released, and the name of the musician who recorded it.

$\Pi_{C.Title, C.Year, M.Name}\left(\left(\sigma_{S.Duration > 3:26}(S) \bowtie_{S.CD=CD.Id} C\right) \bowtie_{M.Id=C.Id} C\right)$

↓ no cheating 0/5

(d) **[5 pts.]** Find all albums that do not have a song longer than 4 minutes. Report the name of the album and the name of the musician who recorded the album.

$\Pi_{CD.Title, M.Name}\left(\left(\sigma_{S.Duration < 4}(S) \bowtie_{S.CD=CD.Id} C\right) \bowtie_{C.Id=M.Id} M\right)$

0/5

Problem 4 *[10 pts.]*

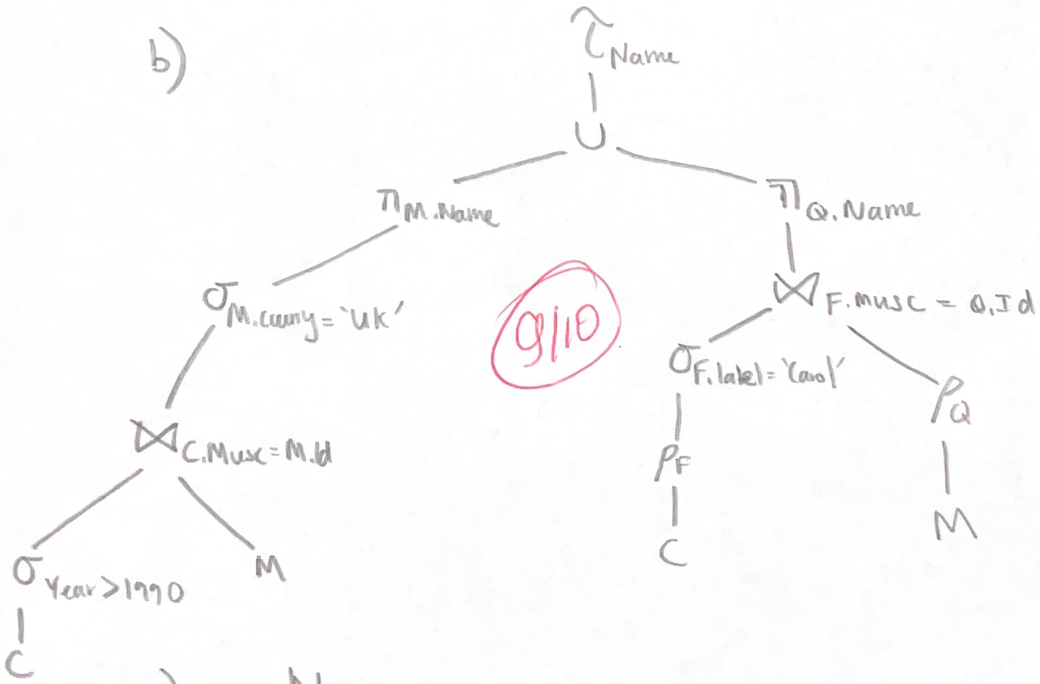
Consider the database from Problem 2. Consider the following relational algebra expression.

$$\tau_{Name}(\pi_{M.Name}(\sigma_{M.Country='UK'}(\sigma_{Year>1990}(C) \bowtie_{C.Musician=M.Id} M)) \cup \pi_{Q.Name}(\sigma_{F.Label='Carol'}(\rho_F(C)) \bowtie_{F.Musician=Q.Id} \rho_Q(M)))$$

(a) Explain the information need that led to this expression in English, (b) draw the query tree, and (c) compute the result of running the expression on the instance on Page 4 of this exam.

a) Find the musicians that had CDs after 1990 that are from UK record all musicians whose label is Carol. Just report the musician names. Sorted -

b)



9/10

c)

Name
Gong
Mark Knopfler
Momus
Nick Cave
Peter Hammill

Problem 5 *[5 pts]*

1. [2 pts]
   What is the effect of the following SQL command?

```
ALTER TABLE Musicians
SET Country = 'United Kingdom'
WHERE Country = 'UK';
```

(2)

Error or fails because ALTER TABLE is used to change schema not data. Have to use UPDATE instead.

2. **[3 pts]** What is the output of the following relational expression (given the instance on Page 4)?

$$\pi_{X+Y+Id}((\rho_{ID+Musician\to X,2*Musician\to Y}(\pi_{ID+Musician,2*Musician}\sigma_{Musician>=5\wedge Musician<8}(C)) \bowtie_{C.Id=M.Id} M))$$

C.ID | X | Y

C.ID	ID+Musc	2·Musc	M.ID	Name	Country
5	10	10	5	Peter	UK
6	11	10	6	Tom	USA
7	12	10	7	Conrad	New Zea
8	14	12	8	Morris	UK
9	16	14	9	NickCac	UK

(3)

X+Y+Id
25
27
29
34
39

Problem 6 *[10 pts]*

True or false?

1. Each relational table can have only one candidate key. → False +
2. Foreign keys cannot consist of multiple attributes. → ~~True~~ False −
3. Relational tables are not allowed to have multiple foreign keys. → False +
4. The size of a cartesian product of two tables with known sizes is always known ahead of time. → True +
5. A semi-join is a join operation that returns only the information from one of the participating tables. → True +
6. If R and S have the same relational schema, $R \cap S$ is always equal to $R-(R-S)$. → ~~False~~ True −
7. Every superkey is a candidate key. → False +
8. Every candidate key is a superkey. → True +
9. If table R has N tuples, then $R \cup (R-R)$ will have N tuples. → True +
10. SQL commands `DROP TABLE X;` and `DELETE FROM X;` have exactly the same effect. → False +

8/10

$R \cap S \rightarrow$ both in R and S

$R - S \rightarrow$ only unique to R

$R - (R-S) \rightarrow$

R ∩ S and R − (R − S) → tuples unique to S

R	
X	Y
B	1
C	3
D	2
G	7

S	
X	Y
E	4
F	5
C	4
G	8

$R \cap S \rightarrow \emptyset$

$R - S \rightarrow$

R	
X	Y
B	1
C	3
D	2
G	7

S	
X	Y
B	1
C	3
E	4
F	6

$R \cap S \rightarrow$ B 1, C 3

$R - S \rightarrow$ D 2, G 7

$R - (R-S) \rightarrow$ B 1, C 3