DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
CSE 3330/5330 - Database Systems and File Structures

Exam #2
Friday November 20, 2020
Due Date: Monday November 23, 2020 @ 11.59 pm

	Total Points	Earned
Multiple Choice	13	
Query Questions	47	
Total	60	

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Multiple Questions. T/F. Fill In the blanks:

1. (1 point) A functional dependency is a relationship between or among:
   - tables
   - rows
   - relations
   - attributes

   ANS: attributes

2. (1 point) If attributes A and B determine attribute C, then it is also true that:
   - A → C.
   - B → C.
   - (A,B) is a composite determinant.
   - C is a determinant

   ANS: (A,B) is a composite determinant

3. (1 point) If attribute A determines both attributes B and C, then it is also true that:
   - A → B.
   - B → A.
   - C → A.
   - (B,C) → A.

   ANS: A → B

4. (1 point) **TRUE/FALSE**: 3NF is designed to cope with Multi valued dependency

   ANS: FALSE

5. (1 point) **TRUE/FALSE:** The cost of a file scan is essentially the same for a heap file and a sorted file.

   ANS: TRUE

6. (3 point) Which of the following symbols do not represent relational operators from the original relational algebra?
   - γ
   - θ
   - δ
   - +
   - ×

   ANS: γ, Θ, δ, x

7. (1point) A BCNF is:
    - loss less join and dependency preserving
    - loss less join but not dependency preserving
    - not loss less join but dependency preserving
    - none of these

    ANS: loss less join but not dependency preserving

8. (3 points) In the **first** normal form, a composite attribute is converted to individual attributes.

9. (1 point) The storage media that is operated directly from computer's central processing unit is considered as
    - primary storage
    - secondary storage
    - tertiary storage
    - all of above

    ANS: primary storage

Query Questions:

1. (4 points) Is the following table in First normal form (1NF). Explain why or why not. If why not convert to 1NF:

Instructor's name	Course code
Prof. George	(CS101, CS154)
Prof. Atkins	(CS152)

ANS:

The given table is not in First Normal form (1NF). In 1NF, each tuple in the table must be unique and there should not be any composite or multivalued attribute. But in the given table, the first tuple has multiple values under Course code. So this table can't be in First Normal Form. We can make this table in 1NF, by making the following changes:

Instructor's name	Course code
Prof. George	**(CS101)**
Prof. George	**(CS154)**
Prof. Atkins	**(CS152)**

2. (8 points) Reference the table below for the next set of questions:

Course code	Course venue	Instructor's name	Department
MA214	Lecture Hall 18	Prof. George	CS Department
ME112	Auditorium building	Prof. John	Electronics Department

a. List all functional dependencies for this table?

ANS:

In the table, the department column is supposed to be dependent on the Instructor's name column. It is because, if we change the name of the professor, we will also have to change the department name the instructor belongs to.

Instructor's name → Department

Further, the course code value determines the course venue, instructor's name, and the department. So, all these attributes are dependent on the course code column.

Course code → {Course venue, Instructor's name, Department}

b. Is this in Second Normal Form (2NF)? Explain why or why not. If why not convert to 2NF.

Ans:

The given table is in Second Normal Form (2NF). For a table to be in Second Normal Form:

- It must be in First Normal Form
- There must be a full functional dependency.

The table satisfies the condition of being in first normal form because the tuples are unique and there aren't any composite or multivalued attributes

Further, the primary key(course code) is unique in the given table and all the other non-prime attributes are dependent on the primary key making them fully functional dependent.

Thus, the given table is considered to be in Second Normal Form.

3. (5 points) Is the following functional dependency in BCNF (**hint**: *check the lossless join*)

   R=ABCDE, F = {A -> BC, C -> DE)

   # Question Incomplete

4. (5 points) Convert the following SQL query to a relational algebra query:

```
select C.name
from LineItem L, Orders O, Customer C, Nation N
where L.oid=O.oid and O.cid=C.cid and C.nid=N.nid
 and N.name = 'Canada' and O.orderdate > '2010-12-31';
```

ANS:

$$\text{COMBINED\_TABLES} \leftarrow \sigma_{\text{L.oid = O.oid AND O.cid = C.cid AND C.nid = N.nid AND N.name = 'Canada' AND O.orderdate > '2010-12-31'}} (\rho_{L}(\text{LineItem}) \times \rho_{O}(\text{Orders}) \times \rho_{C}(\text{Customer}) \times \rho_{N}(\text{Nation}))$$

$$\text{RESULT} \leftarrow \pi_{\text{C.name}} (\text{COMBINED\_TABLES})$$

5. (10 points) For the following question, consider the following schema:

```
Jedi-Teams (master, apprentice)
Jedi(name, side, home-planet)
Government(leader, planet, position)
Inhabitants(specie, planet)
```

   a. Given a query to find all planetary leaders who are apprentices and use the dark side of the force, Express this query in terms of relational algebra:

```
select leader
from Jedi-Teams, Jedi, Government
where apprentice = name and
name = leader and
side = 'dark'
```

ANS:

COMBINED_TABLES ← (Jedi-Teams |X| $_{\text{apprentice = name}}$ (σ $_{\text{side='dark'}}$ (Jedi))) |X| $_{\text{name= leader}}$ (Government)

RESULT ← π_{leader} (COMBINED_TABLES)

   b. Express this query in terms of relational algebra:

```
select count(*), home-planet
from Jedi, Inhabitants
where specie = 'wookies' and
planet = home-planet and
side = 'light'
group by home-planet
```

ANS:

COMBINED_TABLES ← (σ $_{\text{side='light'}}$ Jedi |X| $_{\text{home-planet = planet}}$ (σ $_{\text{specie = 'wookies'}}$ (Inhabitants))
RESULT ← $\pi_{\text{count(*),home-planet}}$ ($_{\text{home-planet}}$ ℑ $_{\text{COUNT (*)}}$ (COMBINED_TABLES)

6. (5 points) Consider the following database schema:

```
Likes (enthusiast, sports)
Frequents (enthusiast, sports_channel)
Serves (sports_channel, sports)
```

Write the relational algebra query that answers the following question: which enthusiast watches only sports channel that play only sport they like?

ANS:

SPORTS_BRODCASTED ← $\pi_{\text{enthusiast, sports}}$ (Frequents * Serves)
RESULT ← $\pi_{\text{enthusiast}}$ (Frequents) – $\pi_{\text{enthusiast}}$ (SPORTS_BROADCASTED – Likes)

7. (10 points) Solve the following relational expressions for relations below:

User

Id	Name	Age	Gender	OccupationId	CityId
1	John	25	Male	1	3
2	Sara	20	Female	3	4
3	Victor	31	Male	2	5
4	Jane	27	Female	1	3

Occupation

OccupationId	OccupationName
1	Software Engineer
2	Accountant
3	Pharmacist
4	Library Assistant

City

CityId	CityName
1	Halifax
2	Calgary
3	Boston
4	New York
5	Toronto

a. $P_{Name}(R_{Age>25}(User))$

Ans:

Name
Victor
Jane

b. $R_{Id > 2 \vee Age != 31}(User)$

Ans:

Id	Name	Age	Gender	OccupationId	CityId
1	John	25	Male	1	3
2	Sara	20	Female	3	4
3	Victor	31	Male	2	5
4	Jane	27	Female	1	3

c. $R_{User.OccupationId = Occupation.OccupationId}$ (User X Occupation)

Ans:

Id	Name	Age	Gender	OccupationId	CityId	OccupationId	OccupationName
1	John	25	Male	1	3	1	Software Engineer
2	Sara	20	Female	3	4	3	Pharmacist
3	Victor	31	Male	2	5	2	Accountant
4	Jane	27	Female	1	3	1	Software Engineer

d. User ⋈ Occupation ⋈ City

ANS:

Id	Name	Age	Gender	OccupationId	CityId	OccupationName	CityName
1	John	25	Male	1	3	Software Engineer	Boston
2	Sara	20	Female	3	4	Pharmacist	New York
3	Victor	31	Male	2	5	Accountant	Toronto
4	Jane	27	Female	1	3	Software Engineer	Boston

e. $P_{Name,Gender}(R_{CityName = "Boston"}(User \bowtie City))$

ANS:

Name	Gender
John	Male
Jane	Female