

CS2102_2021_S1_Final

Exam ID: 17774

Course Name: -

Question #: 1

Consider the following schemas:

students(matric, sname)

workings(pid, matric, since)

projects(pid, pname)

category(pid, cname)

The underlined attributes are the primary key of the schema. You may assume that there can never be any NULL values in the instance. No other constraints can be assumed.

[2 marks] Complete the relational algebra expression below to find the pair of different students' matric number (m1,m2) working on the same project, excluding students not working on any project.

$\pi([_A_], \sigma(_B_ \wedge _C_ , (p(w1(p1,m1,s1), workings) \times p(w2(p2,m2,s2), workings))))$

 A = 1

 B = 2 (*must only be relational operations*)

 C = 3 (*must only be relational operations*)

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Question #: 2

Consider the following schemas:

students(matric, sname)

workings(pid, matric, since)

projects(pid, pname)

category(pid, cname)

The underlined attributes are the primary key of the schema. You may assume that there can never be any NULL values in the instance. No other constraints can be assumed.

[2 marks] Complete the relational algebra expression below to find the oldest projects pid in the database. The oldest project is the project with the smallest value of since attribute. You may compare the since attributes with standard relational operators (e.g., <, >, <=, >=, ==, !=).

$\pi([_A_], (\pi([_B_], _C_], workings) - \pi([p2, s2], \sigma(_D_ > _E_], (p(w1(p1, m1, s1), workings) \times p(w2(p2, m2, s2), workings))))))$

All answers must be single attributes

__A__ = 1

__B__ = 2

__C__ = 3

__D__ = 4

__E__ = 5

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Question #: 3

Consider the following schemas:

students(matric, sname)

workings(pid, matric, since)

projects(pid, pname)

category(pid, cname)

The underlined attributes are the primary key of the schema. You may assume that there can never be any NULL values in the instance. No other constraints can be assumed.

[3 marks] Complete the SQL create table statement below to create the schema above. The first table (i.e., students table) has been filled in for you.

```
CREATE TABLE students (  
  matric VARCHAR(9) PRIMARY KEY,  
  sname  VARCHAR(50)  
);  
  
CREATE TABLE projects (  
  1 VARCHAR(9) 2,  
  3 VARCHAR(50)  
);  
  
CREATE TABLE workings (  
  4 VARCHAR(9) REFERENCES 5,  
  6 VARCHAR(9) REFERENCES 7,  
  8 DATE,  
  PRIMARY KEY(pid, matric)  
);  
  
CREATE TABLE category (  
  9 VARCHAR(9) REFERENCES 10,  
  11 VARCHAR(9),  
  PRIMARY KEY(pid, cname)  
);
```

Question #: 4

Consider the following schemas:

students(matric, sname)

workings(pid, matric, since)

projects(pid, pname)

category(pid, cname)

The underlined attributes are the primary key of the schema. You may assume that there can never be any NULL values in the instance. No other constraints can be assumed.

[3 marks] Complete the SQL query below to find all pair of distinct projects' pid (p1, p2) such that the two projects have exactly the same set of categories.

```
SELECT P1.pid, P2.pid
FROM projects P1, projects P2
WHERE __D__
AND ( SELECT COUNT(*)
      FROM ( SELECT __A__ FROM category C0 WHERE __B__
              __E__
              SELECT __A__ FROM category C0 WHERE __C__ ) AS T1 )
=
( SELECT COUNT(*)
  FROM ( SELECT __A__ FROM category C0 WHERE __B__
          __F__
          SELECT __A__ FROM category C0 WHERE __C__ ) AS T2 )
```

All blanks must be short answers, they cannot be nested queries.

__A__ = 1

__B__ = 2 (cannot add additional clauses such as GROUP BY, etc as well as AND and OR conditions)

__C__ = 3 (cannot add additional clauses such as GROUP BY, etc as well as AND and OR conditions)

__D__ = 4

__E__ = 5

__F__ = 6

Question #: 5

Consider the following schemas:

students(matric, sname)

workings(pid, matric, since)

projects(pid, pname)

category(pid, cname)

The underlined attributes are the primary key of the schema. You may assume that there can never be any NULL values in the instance. No other constraints can be assumed.

[3 marks] Consider the following result for the following SQL query

SELECT *

FROM students NATURAL JOIN workings

NATURAL JOIN projects

NATURAL JOIN category;

matric | sname | pid | since | cname

```
-----+-----+-----+-----+-----
A0001 | AA   | P01 | 2002 | CA
A0001 | AA   | P01 | 2002 | CB
A0001 | AA   | P02 | 2004 | CB
A0002 | BB   | P01 | 2003 | CA
A0002 | BB   | P01 | 2003 | CB
A0003 | CC   | P03 | 2004 | CA
A0003 | CC   | P03 | 2004 | CC
A0003 | CC   | P03 | 2004 | CD
A0004 | AA   | P03 | 2004 | CA
A0004 | AA   | P03 | 2004 | CC
A0004 | AA   | P03 | 2004 | CD
```

You are further told that the result of running the SQL query on Question 4 is

pid | pid

```
-----+-----
P01 | P04
P04 | P01
P03 | P05
P05 | P03
```

What is the result of the following SQL query?

SELECT PID FROM category

EXCEPT ALL

SELECT DISTINCT pid FROM category WHERE cname != 'CA';

If you have fewer than 6 rows, write the answer as -. *Leaving your answer as blank constitutes not answering the question.*

Exclude quote symbols in your answer. For instance, write CS2102 insted of 'CS2102' if that is your answer.

pid

1

2

3

4

5

6

Question #: 6

Consider the schema $R(A, B, C, D, E)$ with $F = \{BDE \rightarrow AE, AD \rightarrow C, CD \rightarrow E, BE \rightarrow AD\}$.

[2 marks] Write four completely non-trivial functional dependencies that are *implied* by F but not in F . If you have fewer than 4 functional dependencies, write the answer as -. *Leaving your answer as blank constitutes not answering the question.*

FD1 = 1

FD2 = 2

FD3 = 3

FD4 = 4

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Question #: 7

Consider the schema $R(A, B, C, D, E)$ with $F = \{BDE \rightarrow AE, AD \rightarrow C, CD \rightarrow E, BE \rightarrow AD\}$.

[2 marks] Write at most four superkeys of R with at most 3 attributes. If you have fewer than 4 superkeys, write the answer as -. *Leaving your answer as blank constitutes not answering the question.*

Superkey 1 = 1

Superkey 2 = 2

Superkey 3 = 3

Superkey 4 = 4

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Question #: 8

Consider the schema $R(A, B, C, D, E)$ with $F = \{BDE \rightarrow AE, AD \rightarrow C, CD \rightarrow E, BE \rightarrow AD\}$.

[3 marks] Write all keys of R with at most 3 attributes. If you have fewer than 4 keys, write the answer as -. *Leaving your answer as blank constitutes not answering the question.*

Key 1 = 1

Key 2 = 2

Key 3 = 3

Key 4 = 4

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Question #: 9

Consider the schema $R(A, B, C, D, E)$ with $F = \{BDE \rightarrow AE, AD \rightarrow C, CD \rightarrow E, BE \rightarrow AD\}$.

[5 marks] Write one possible lossless-join valid BCNF decomposition of R into exactly three fragments such that each fragment has exactly three attributes.

Each blank is a single attribute in uppercase.

$R_1(\underline{\quad 1 \quad}, \underline{\quad 2 \quad}, \underline{\quad 3 \quad})$

$R_2(\underline{\quad 4 \quad}, \underline{\quad 5 \quad}, \underline{\quad 6 \quad})$

$R_3(\underline{\quad 7 \quad}, \underline{\quad 8 \quad}, \underline{\quad 9 \quad})$

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Question #: 10

[1 mark] Is your decomposition in Question 9 a dependency-preserving decomposition?

Question #: 11

Consider the schema $R(A, B, C, D, E)$ with $F = \{BDE \rightarrow AE, AD \rightarrow C, CD \rightarrow E, BE \rightarrow AD\}$.

[3 marks] Write one possible minimal cover of F . Write your answer in the same comma-separated format as above, but without the curly brackets.

Minimal Cover = { 1 }

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Question #: 12

Consider the schema $R(A, B, C, D, E)$ with $F = \{BDE \rightarrow AE, AD \rightarrow C, CD \rightarrow E, BE \rightarrow AD\}$.

[5 marks] Write one possible lossless-join dependency-preserving valid decomposition of R that has exactly three fragments. Write the attribute of each fragment as comma-separated value as above.

Each blank is a comma-separated single attribute in uppercase.

R1(1)

R2(2)

R3(3)

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Question #: 13

[4 marks] We know that Armstrong's axioms are both sound and complete. Consider the augmentation rule in Armstrong's axioms:

if $A \rightarrow B$ then $AC \rightarrow BC$

Our aim in this question is to show that the "reverse" of the augmentation rule is not sound. By the "reverse", we meant the following rule:

if $AC \rightarrow BC$ then $A \rightarrow B$

To show that it is unsound, we want to imply the following:

$\{\} \models A \rightarrow B$

In other words, any functional dependencies are implied if we allow "reverse" augmentation rule. Note that you are not allowed to use the decomposition and union rule from extended Armstrong's axioms. The following example shows the use of Armstrong's axioms in a proof:

$A \rightarrow B$ [Given]

$A \rightarrow C$ [Given]

$AB \rightarrow A$ [Reflexivity]

$A \rightarrow AB$ [Augmentation (1) with A]

$AB \rightarrow BC$ [Augmentation (2) with B]

$A \rightarrow BC$ [Transitivity (4) and (5)]

To use "reverse" augmentation:

$AC \rightarrow BC$ [Given]

$A \rightarrow B$ [Remove C from (1)]

Your proof should not exceed 3 lines. If you have fewer than 3 lines, write the answer as -.

Leaving your answer as blank constitutes not answering the question.

Blank number 1, 2, 4, 5, 7 and 8 are single/multi attributes in uppercase not separated by commas.

Blank number 3, 6 and 9 are reasons.

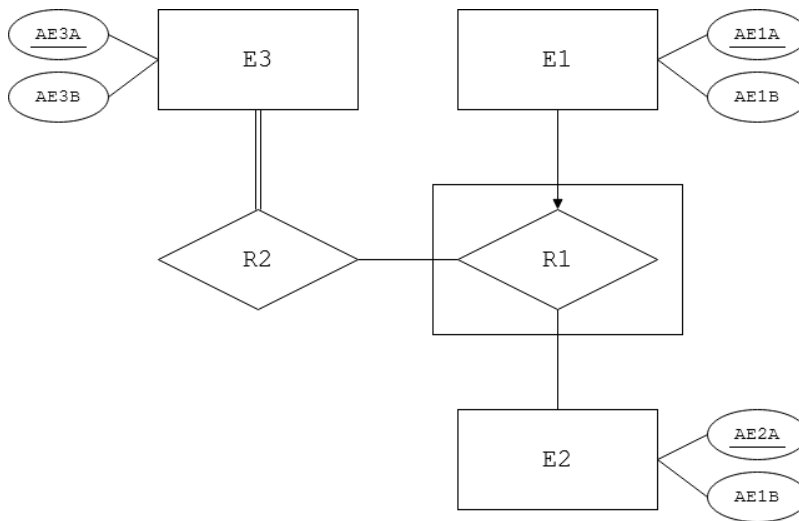
<u>1</u>	\rightarrow	<u>2</u>	[<u>3</u>]
<u>4</u>	\rightarrow	<u>5</u>	[<u>6</u>]
<u>7</u>	\rightarrow	<u>8</u>	[<u>9</u>]

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Question #: 14

[1 mark] Find the mistake in the ER diagram below. If the mistake is on a line, make sure your pin is on the line outside of any box/diamond/oval. If the mistake is in the arrow make sure your pin is on the arrow. If the mistake is on the box/diamond/oval, make sure your pin is inside them without touching any other lines.



Question #: 15

[1 mark] Find the mistake in the ER diagram below. If the mistake is on a line, make sure your pin is on the line outside of any box/diamond/oval. If the mistake is in the arrow make sure your pin is on the arrow. If the mistake is on the box/diamond/oval, make sure your pin is inside them without touching any other lines.

