CS2102_1920_S1_final_v3

Exam ID: 11511 **# of Questions:** 15

Question #: 1

Relational algebra [2 mark]

Given two relational algebra expression E_1 and E_2, we use the notation E_1=E_2 to indicate that the two expressions are equivalent.
Consider 5 equivalences below:

Equivalence 1	$\sigma_C(E_1 - E_2) = \sigma_C(E_1) - E_2$
Equivalence 2	$\pi_A(\pi_B(E)) = \pi_A(E)$
Equivalence 3	$\sigma_{C_1}(E_1 \bowtie_{C_2} E_2) = \sigma_{C_2}(E_1 \bowtie_{C_1} E_2)$
Equivalence 4	$(E_1 \bowtie_{C_1} E_2) \bowtie_{C_2 \wedge C_3} E_3 = E_1 \bowtie_{C_1 \wedge C_2} (E_2 \bowtie_{C_3} E_3)$
Equivalence 5	$(E_1 \bowtie E_2) \bowtie E_3 = E_1 \bowtie (E_2 \bowtie E_3)$

Which of the equivalences are true?

A. Equivalence 1
B. Equivalence 2
C. Equivalence 3
D. Equivalence 4
E. Equivalence 5
F. None of the above

Item Weight: 2.0

Question #: 2

Relational algebra [2 mark]

Consider the following relational database where the domain of each attribute is integer:
•R1 (<u>a</u>, b, c)
•R2 (<u>c</u>, d, e)
•R3 (<u>e</u>, f, g)

Consider the following SQL query:

```
WITH cte AS (
 SELECT c, e FROM R1 NATURAL JOIN R2 NATURAL JOIN R3
)
SELECT DISTINCT c FROM cte
WHERE  e NOT IN ( SELECT e FROM R3 WHERE e >30 );
```

Consider the following four relational algebra expression below:

E1	$\pi_c(\pi_{c,e}(R1 \bowtie R2 \bowtie R3) \cup \pi_{c,e}(\sigma_{c>30}(R1 \bowtie R2 \bowtie R3)))$
E2	$\pi_c(R1 \bowtie R2 \bowtie R3) - \pi_c(\sigma_{e>30}(R1 \bowtie R2 \bowtie R3))$
E3	$\pi_c(\pi_{c,e}(R1 \bowtie R2 \bowtie R3) \cap \pi_{c,e}(\sigma_{c\leq 30}(R1 \bowtie R2 \bowtie R3)))$
E4	$\pi_c(\sigma_{e\leq 30}(R1 \bowtie R2 \bowtie R3))$

Which of the relational algebra expressions are equivalent to the SQL query above assuming that the tables are non-empty?

A. E1
B. E2
C. E3
D. E4
E. None of the above

Item Weight: 2.0

Question #: 3

SQL queries [2 mark]

Consider the following relational database where the domain of each attribute is integer:

•R1 (<u>a</u>, b, c)
•R2 (<u>c</u>, d, e)
•R3 (<u>e</u>, f, g)

Which of the following queries may contain duplicate entries? All queries are valid queries.

A. SELECT R1.a, R3.g
FROM   R1, R2, R3
WHERE R1.c = R2.c AND R2.e = R3.e;

B. SELECT R1.a, RT.g
FROM R1, (R2 NATURAL JOIN R3) AS RT
WHERE RT.c = RT.c;
C. SELECT R1.a, RT.g
FROM R1 NATURAL JOIN (R2 NATURAL JOIN R3) AS RT
WHERE R1.c = RT.c;
D. SELECT b, g
FROM R1 NATURAL JOIN R2 NATURAL JOIN R3;
E. None of the above

Item Weight: 2.0

Question #: 4

Functional dependencies [2 mark]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

Which of the following are parts of the prime attribute of R with respect to F?

•R1 (a, b, c)
•R2 (c, d, e)
•R3 (e, f, g)

Which of the following are parts of the prime atttributes of R with respect to F?

A. A
B. B
C. C
D. D
E. E

Item Weight: 2.0

Question #: 5

Functional dependencies [2 mark]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

Write down all the keys of R. You simply need to write the attributes (in uppercase) for each key without the comma. You may leave any spot blank if you feel that there are fewer than 5 keys.

The set of keys are: {{___1___}, {___2___}, {___3___}, {___4___}, {___5___}}

1. _______
2. _______
3. _______
4. _______
5. _______

Item Weight: 2.0

Question #: 6

Minimal cover [2 mark]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

Compute one possible minimal cover of F with respect to R. You are limited to only up to five functional dependencies in your minimal cover.

One possible minimal cover is G = {___1___ -> ___2___, ___3___ -> ___4___, ___5___ -> ___6___, ___7___ -> ___8___, ___9___ -> ___10___}

1. _______
2. _______
3. _______
4. _______
5. _______
6. _______
7. _______
8. _______
9. _______
10. _______

Item Weight: 2.0

Question #: 7

Armstrong's axioms [5 mark]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

Using extended Armstrong's axioms, fill in the steps to show that F |= CD -> ABCDE. You are limited to only up to five steps in the proof *including* the use of [Given] if necessary. Use the following example usage for your reasoning:

A -> B [Given]

B -> C [Given]

AB -> B [Reflexivity]

AC -> BC [Augmentation (1) with C]

A -> C [Transitivity (1) and (2)]

AC -> B [Decomposition of (4)]

A -> BC [Union (1,5)]

Proof:

__1__ -> __2__ [__3__]

__4__ -> __5__ [__6__]

__7__ -> __8__ [__9__]

__10__ -> __11__ [__12__]

CD -> ABCDE [__13__]

1. _______
2. _______
3. _______
4. _______
5. _______
6. _______
7. _______
8. _______
9. _______
10. _______
11. _______
12. _______
13. _______

Item Weight: 5.0

Question #: 8

Normal forms [2 mark]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

Which of the following functional dependencies are in F^+ and violates 3NF property of R?

A. CE -> D
B. AE -> D
C. AD -> E
D. D -> AE
E. DE -> A
F. C -> AB
G. None of the above

Item Weight: 2.0

Question #: 9

Normal forms [4 marks]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

We consider BCNF to be better than 3NF. Consider a lossless-join and dependency-preserving decomposition that minimizes redundancies using only either Algorithm#6 for BCNF decomposition or Algorithm#7 and Algorithm#2 for 3NF decomposition.

Find the *best lossless-join and dependency-preserving* decomposition achievable by R with respect to F. You are limited to only up to 3 relations in your answer.

The best decomposition is (fill in either BCNF or 3NF) [__1__]

The decompositions are { R1(__2__), R2(__3__), R3(__4__) }

1. _______
2. _______
3. _______
4. _______

Item Weight: 4.0

Question #: 10

Decomposition [2 mark]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

Which of the following decompositions are lossless-join decomposition?

A. R1(A,B,C), R2(B,C,D), R3(C,D,E)
B. R1(A,B,D), R2(A,C,D), R3(B,D,E)
C. R1(A,B,E), R2(B,C,E), R3(B,D,E)
D. R1(A,B,E), R2(A,C,D), R3(A,D,E)
E. R1(A,B,C), R2(B,C,D), R3(C,D,E)
F. None of the above

Item Weight: 2.0

Question #: 11

Decomposition [2 mark]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

Further consider the decomposed schema d = { R1(A,B,C), R2(B,C,D), R3(C,D,E) }. Which of the following functional dependencies are not preserved by the decomposition?

A. AB -> C
B. AC -> BD
C. C -> AB
D. D -> AE
E. BD -> AC
F. None of the above

Item Weight: 2.0

Question #: 12

Decomposition and SQL queries [2 mark]

Consider the following schema R(A,B,C,D,E) with the following set of functional dependencies F = { AB -> C, AC -> BD, C -> AB, D -> AE, BD -> AC }.

Further consider the fragment R1(A,B,C) and its corresponding F_{R1}. Which of the following SQL code will correctly create the table corresponding to R1 *that preserves the functional dependencies in* F_{R1} assuming that all its attributes are in the domain of integer.

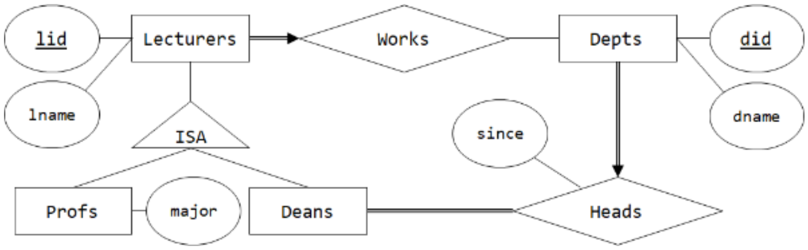
A. CREATE TABLE R1 (
A integer NOT NULL,
B integer NOT NULL,
C integer PRIMARY KEY,
UNIQUE (A, B)
);
B. CREATE TABLE R1 (
A integer,
B integer,
C integer NOT NULL,
PRIMARY KEY (A, B)
);
C. CREATE TABLE R1 (
A integer,
B integer,
C integer UNIQUE NOT NULL,
UNIQUE (A, B)
);
D. CREATE TABLE R1 (
A integer UNIQUE NOT NULL,
B integer UNQIUE NOT NULL,
C integer PRIMARY KEY
);
E. CREATE TABLE R1 (
A integer,
B integer,
C integer UNIQUE NOT NULL,
PRIMARY KEY (A, B)
);
F. None of the above

Item Weight: 2.0

Question #: 13

ER diagram [3 mark]

Consider the following ER diagram where the ISA relationship satisfies both covering and overlapping constraints.



Further consider the following relational schema where we assume that all attributes are in integer domain.

```
CREATE TABLE Depts (
 did   integer PRIMARY KEY,
 dname integer NOT NULL
);
CREATE TABLE Deans (
 lid   integer PRIMARY KEY,
 lname integer NOT NULL,
 did   integer NOT NULL REFERENCES Depts (did)
);
CREATE TABLE Profs (
 lid   integer PRIMARY KEY,
 lname integer NOT NULL,
 major integer NOT NULL,
 did   integer NOT NULL REFERENCES Depts (did)
);
CREATE VIEW Lecturers AS (
 SELECT lid, lname FROM Deans UNION SELECT lid, lname FROM Profs
);
CREATE TABLE Heads (
 lid   integer NOT NULL REFERENCES Deans (lid),
 since integer NOT NULL,
 did   integer PRIMARY KEY
);
```

Select all the statements that are true about the relational schema.

A. The relational schema enforces key constraint on Lecturers with respect to Works.
B. The relational schema enforces total participation constraint on Lecturers with respect to Works.

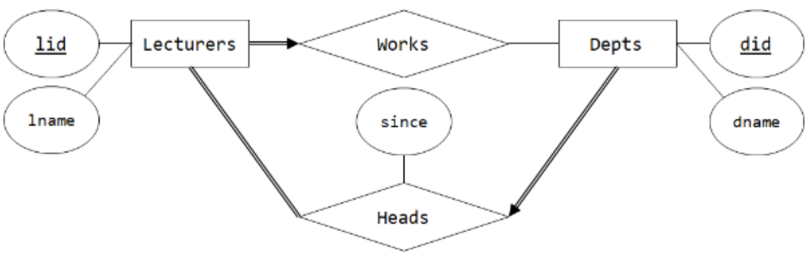
C. The relational schema enforces key constraint on Depts with respect to Heads.
D. The relational schema enforces total participation constraint on Depts with respect to Heads.
E. The relational schema enforces total participation constraint on Deans with respect to Heads.
F. The relational schema enforces covering constraint of the ISA
G. The relational schema enforces overlap constraint of the ISA
H. None of the above

Item Weight: 3.0

Question #: 14

ER diagram [3 marks]

Consider the following ER diagram where the ISA relationship satisfies both covering and overlapping constraints.



Consider the following relations
•Lecturers (lid, lname)
•Depts (did, dname)
•Works (lid, did)
•Heads (lid, did, since)

Further consider the natural join of all relations above (let's call this All (lid, lname, did, dname, since)). Which of the following functional dependencies is *induced* by the ER diagram on relations All? By *induced*, we mean the functional dependencies are the result of the ER diagram (i.e., generated by the ER diagram). As an example, the functional dependencies lid -> lname and did -> dname are both induced due to the primary key on Lecturers and Depts relations respectively.

A. did -> lname
B. lid -> dname

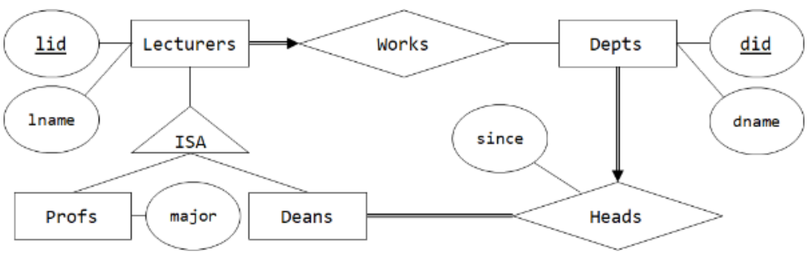
C. did -> major
D. lid -> major
E. did -> since
F. lid -> since
G. None of the above

Item Weight: 3.0

Question #: 15

ER diagram abd SQL query [5 mark]

Consider the following ER diagram where the ISA relationship satisfies both covering and overlapping constraints.



Further consider the following relational schema where we assume that all attributes are in integer domain.

We say that a dean is *important* if the dean heads a department where either:
•There are at least 20 professors working in the department excluding the dean, or
•There are at least 5 professors with different majors working in the department

Find all the *non-important* dean. **Your answer should not contain any CTE**.
Answer the question by creating SQL view with the schema shown below:

CREATE VIEW qn15(lid, lname) AS (

);

Your answer should include the VIEW.

____
____
____

Item Weight: 5.0