NATIONAL UNIVERSITY OF SINGAPORE

CS2102 – DATABASE SYSTEMS
(Semester 1 AY2016/2017)

Time Allowed: 2 Hours

INSTRUCTIONS TO CANDIDATES

1. Please write your Student Number only. Do not write your name.

2. This assessment paper contains **THREE (3)** exercises and comprises **EIGHT (8)** printed pages.

3. Students are required to answer **ALL** questions

4. Students should write the answers on the OCR form or within the space provided, as indicated.

5. This is a **Closed Book** assessment.

6. One double sided page (A4 size) of notes is permitted.

7. Electronic calculators are permitted.

STUDENT NO:

This portion is for examiner's use only

EXERCISE	MARKS	REMARK
E I (12) Q1-Q6		OCR
E II (8) Q7-Q10		OCR
E II (24) Q11-Q15		
E III (16) Q16-Q17		
Total (60)		

This is a series of multiple choice questions (questions **1** to **10**) and short essay questions (questions **11** to **17**).

For each **multiple choice question** choose the best answer and report the corresponding choice onto the **OCR form.** No mark is deducted for wrong answers.

For each **short essay question** give your answer **in the reserved space in the script.** Marks may be deducted for unnecessary comments and wrong answers.

Exercise I. (12 marks) Let us consider the relation R(A, B, C, D, E) with the following set F of functional dependencies.

$$F = \{\{A, B\} \to \{B, C\}, \{A, B\} \to \{C, D\}, \{D\} \to \{D, E\}, \{C\} \to \{A\}, \{D, E\} \to \{D\}, \{B, C\} \to \{E\}\}$$

It is advised that you study and normalize R with F before answering the following questions

Question 1. (2 marks) Which of the following functional dependencies is **not** in F+?

a) $\{B, C\} \to \{D\}$.
b) $\{A, B, C\} \to \{A, B, C, D, E\}$.
c) $\{E\} \to \{D\}$.
d) All of the above (none of them is in F+).
e) None of the above (they are all in F+).

Question 2. (2 marks) Which of the following functional dependencies is trivial?

a) $\{B, C\} \to \{B, C, D\}$.
b) $\{A, B, C\} \to \{A, B, C, D, E\}$.
c) $\{E, D\} \to \{D\}$.
d) All of the above.
e) None of the above.

Question 3. (2 marks) Which of the following functional dependencies is completely non-trivial and in F+?

a) $\{B, C\} \to \{D\}$.
b) $\{A, B, C\} \to \{A, B, C, D, E\}$.
c) $\{E, D\} \to \{D\}$.
d) All of the above.
e) None of the above.

Question 4. (2 marks) Which of the following is **not** a superkey of R with F?

a) $\{A, B, E\}$
b) $\{A, B, C\}$
c) $\{A, D\}$
d) All of the above (none is a superkey).
e) None of the above (all are superkeys).

Question 5. (2 marks) Which of the following is a candidate key of R with F?

a) $\{C, B\}$
b) $\{D, B\}$
c) $\{E, C\}$
d) All of the above.
e) None of the above.

Question 6. (2 marks) Which of the following sets of functional dependencies is a minimal cover of F?

a) $\{\{A, B\} \to \{C, D\}, \{C\} \to \{A\}, \{D\} \to \{E\}, \{B, C\} \to \{A\}\}$
b) $\{\{A, B\} \to \{C, D\}, \{C\} \to \{A\}, \{D\} \to \{E\}, \{B, C\} \to \{E\}\}$
c) $\{\{A, B\} \to \{C, D\}, \{C\} \to \{A\}, \{D\} \to \{E\}\}$
d) All of the above.
e) None of the above.

Exercise II. (24 marks) Consider the following self-describing schema. It is the schema of the database of an event organizer company. Prime attributes are underlined.

```
event(eid, ename, ecity)
registration(cid, eid)
customer(cid, cname, ccity)
```

The table `event` stores the identifier, `eid`, the name, `ename`, of events organized by the company and the city, `ecity`, where the event takes place. The primary key is {`eid`}.
The table `customer` stores the identifier, `cid`, the name, `cname`, of customers and the city where the customer lives, `ccity`. The primary key is {`cid`}.
The table `registration` stores the registrations of customers to event. The composite primary key is {`cid`, `eid`}. Two referential integrity constraints on the table `registration` guarantee that the customer exists and that the event exists, respectively.

There can be events without registration and customers who have not registered to any event.
In addition to the primary and foreign key constraints, no attribute is null. No constraint other than the above is enforced. For instance, there can be several events with the same name.
Consider that every foreign key constraint is annotated with ON UPDATE CASCADE and ON DELETE CASCADE.

Question 7. (2 marks) Which of the following operations <u>never</u> violates a constraint on the `registration` table?

    a) Insert a record into the `registration` table.
    b) Delete a record from the `registration` table.
    c) Update a record of the `registration` table.
    d) All of the above.
    e) None of the above.

Question 8. (2 marks) Which of the following operations may violate a FOREIGN KEY constraint on the `registration` table?

    a) Delete a record from the `event` table.
    b) Delete a record from the `customer` table.
    c) Update a record of the `customer` table.
    d) All of the above.
    e) None of the above.

Question 9. (2 marks) Which of the following queries finds the names of the events in London?

    a) $\{<Y> \mid \forall X \ (event(X, Y, \text{'London'}))\}$.
    b) $\{<Y> \mid \forall X \ \forall Z \ (event(X, Y, Z) \land Z = \text{'London'})\}$.
    c) $\{<Y> \mid \exists X \ \exists Z \ (event(X, Y, Z) \land Z = \text{'London'})\}$.
    d) All of the above
    e) None of the above.

Question 10. (2 marks) Which of the following queries finds the identifiers of the events that have no customer registered?

    a) $\{<X> \mid \exists Y \ \exists Z \ \forall U \ \forall V \ \forall T \ (event(X, Y, Z) \land (customer(U, V, T) \Rightarrow \neg \ registration(U, X)))\}$.
    b) $\{<X> \mid \exists Y \ \exists Z \ \forall U \ (event(X, Y, Z) \land \neg \ registration(U, X))\}$.
    c) $\{<X> \mid \exists Y \ \exists Z \ \forall U \ \neg \ (\neg \ event(X, Y, Z) \lor registration(U, X))\}$.
    d) All of the above.
    e) None of the above.

```
event(eid, ename, ecity)
registration(cid, eid)
customer(cid, cname, ccity)
```

Translate the following queries into the indicated language. Use your knowledge of integrity constraints to simplify the queries. For SQL queries, do not use nested queries in the SELECT and FROM clause, if possible and unless otherwise indicated. For SQL queries, prefer simpler queries to aggregate queries, to nested queries, to queries with algebra operators (UNION, INTERSECT, JOIN, EXCEPT, MINUS etc.) and other complicated answers, if possible and unless otherwise indicated.

Question 11. (4 marks) (Algebra) Find the names of the customers who registered to some of the events taking place in the city where they live. Do not use Join operators ($\bowtie$); prefer Cartesian Product ($\times$). Feel encouraged drawing the query as a tree.

Question 12. (4 marks) (SQL) Find the names of the customers who registered to some of the events taking place in the city where they live.

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```
event(eid, ename, ecity)
registration(cid, eid)
customer(cid, cname, ccity)
```

Question 13. (4 marks) (SQL) Find the different cities with the largest number of events.

Question 14. (6 marks) (TRC) Find the names of the events in London that have no registered customer living in Paris.

```
event(eid, ename, ecity)
registration(cid, eid)
customer(cid, cname, ccity)
```

Question 15. (6 marks) (SQL) Find the names of the customers who registered to all the events taking place in the city where they live.

Exercise III. (16 marks) Let us consider a relation with 3 attributes R(A, B, C).

Question 16. (8 marks) Propose a <u>smallest</u> (number of functional dependencies) and <u>minimal</u> (no redundancy) set of functional dependencies F on R of your choice such that R with F is <u>not in 3NF</u>.

F = {

Give the candidate keys of R with F (use the F that you have proposed). Just give the answer do not show the steps.

Explain why R with F (use the F that you have proposed) is not in 3NF (be concise).

R with F is not in 3NF because

Find a lossless dependency preserving decomposition of R with F (use the F that you have proposed). Just give the fragments.

Question 17. (8 marks) Propose a <u>smallest</u> (number of functional dependencies) and <u>minimal</u> (no redundancy) set of functional dependencies F on R of your choice such that R with F is in <u>3NF</u> but <u>not in BCNF</u>.

F = {

Give the candidate keys of R with F (use the F that you have proposed). Just give the answer do not show the steps.

Explain why R with F (use the F that you have proposed) is not in BCNF (be concise).

R with F is not in BCNF because

Explain why R with F (use the F that you have proposed) is in 3NF (be concise).

R is in 3NF because

-- END OF PAPER ---