NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING
Final examination for
Semester 1 AY2011/2012

CS2102 – DATABASE SYSTEMS

November 2011 Time Allowed: 2 Hours

INSTRUCTIONS TO CANDIDATES

1. This examination paper contains **THREE (3)** exercises and comprises **NINE (9)** printed pages.
2. Answer **ALL** questions.
3. Answer **ALL** questions on the OCR form or within the space provided **ONLY**, as indicated.
4. **Unnecessary** comments will be penalised.
5. This is a **Closed Book** examination.
6. **Please write your Matriculation Number Below.**

MATRICULATION NO: | | | | | | | | | | |

This portion is for examiner's use only

EXERCISE	MARKS	REMARK
E I (50)		OCR
E II (32)		
E III (18)		
Total (100)		

This is a series of multiple choice questions (questions **1** to **25**) and short essay questions (questions **26** to **40**).

For each **multiple choice question** choose the best answer and report the corresponding choice onto the **OCR form.** Each multiple choice question is worth 2 marks. No mark is deducted for wrong answers.

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

Exercise I. (50 marks) Multiple choice questions. Answer on the OCR form.

For the next 10 questions, consider the following two tables: T1(A, B, C) and T2(A, D). The attribute A is the primary key of T1. T2 does not have a primary key. The attribute A is a foreign key of T2 referencing T1. There is no cascading instruction. Consider the following instances of T1 and T2, respectively.

T1		
A	B	C
1	0	1
2	1	2
3	1	3
4	2	2
5	1	5

T2	
A	D
1	1
2	2
3	3
4	2
4	2
5	5

Question 1. What is the cardinality of the result of the following query?

```
SELECT T1.A FROM T1, T2 WHERE T1.A = T2.A
```

a) 0
b) 5
c) 6
d) 25
e) 30

Question 2. Which of the following t-uples is not in the result of the following query?

```
SELECT COUNT(*) FROM T1, T2 WHERE T1.A = T2.A GROUP BY T1.A
```

a) <0>
b) <1>
c) <2>
d) They are all in the result
e) None of them is in the result

Question 3. What is the result of the following query?

```
SELECT COUNT(*)  FROM T1, T2 WHERE T1.A = 6
```

a) ∅
b) {<0>}
c) {<1>}
d) {<30>}
e) An error

Question 4. What is the result of the following query?

```
SELECT COUNT(*)  FROM T1, T2 WHERE T1.A <= 6
```

a) ∅
b) {<0>}
c) {<1>}
d) {<30>}
e) An error

Question 5. What is the result of the following query?

SELECT T2.A FROM T1, T2 WHERE T1.A = T2.A GROUP BY T1.A HAVING COUNT(*) >1

a) $\varnothing$
b) {<0>}
c) {<1>}
d) {<2>}
e) An error

Question 6. What is the result of the following query?

$\{<Y1> \mid \exists X1\ \exists Z1\ \forall X2\ \forall Y2\ \forall Z2\ (T1(X1, Y1, Z1) \wedge (T1(X2, Y2, Z2) \Rightarrow X1 \leq X2))\}$

a) $\varnothing$
b) {<0>}
c) {<1>}
d) {<2>}
e) {<3>}

Question 7. Which of the following updates on the instances above is going to be rejected?

a) Delete t-uple <1,0,1> from T1
b) Insert t-uple <1,0,2> into T1
c) Insert t-uple <0,0> into T2
d) All of the above (they are all rejected)
e) None of the above (they are all committed)

Question 8. Which of the following updates on the instances above is going to be rejected?

a) Delete t-uple <3,3> from T2
b) Insert t-uple <6,0,2> into T1
c) Insert t-uple <3,3> into T2
d) All of the above (they are all rejected)
e) None of the above (they are all committed)

Question 9. Which of the following updates is always committed?

a) Delete a t-uple from T1
b) Insert a t-uple into T2
c) Delete a t-uple from T2
d) All of the above (they are all committed)
e) None of the above (they are all rejected)

Question 10. Which of the following queries is unsafe?

a) $\{<X1> \mid \forall Y1\ \forall Z1\ (T2(Y1, Z1) \Rightarrow T1(X1, Y1, Z1))\}$
b) $\{<X1> \mid \exists Y1\ \exists Z1\ (T1(X1, Y1, Z1))\}$
c) $\{<X1> \mid \forall Y1\ \forall Z1\ (\neg\ (T1(X1, Y1, Z1)) \wedge T2(X1, X1))\}$
d) All of the above (they are all unsafe)
e) None of the above (they are all safe)

For the next 15 questions, consider the following relation with the following set of functional dependencies.

R = {A, B, C, D, E, G, H}

F= {{A}→ {D}, {A, E} → {H}, {D, G} → {B, C}, {A, D, G} → {C}, {E} → {C}, {H} → {E}, {H} → {C}}.

Question 11. Which of the following functional dependencies is a functional dependency in F+?

a) {A, D} → {D}
b) {H} → {C}
c) {A, H} → {E}
d) All of the above
e) None of the above

Question 12. Which of the following functional dependencies is a functional dependency in F+?

a) {A, H} → {E}
b) {A, E, G} → {C}
c) {A, H} → {C}
d) All of the above
e) None of the above

Question 13. Which of the following functional dependencies is a trivial functional dependency in F+?

a) {A, D} → {D}
b) {H} → {C}
c) {A, H} → {E}
d) All of the above
e) None of the above

Question 14. Which of the following functional dependencies is a non trivial functional dependency in F+?

a) {A, D} → {D}
b) {E} → {H}
c) {A, H} → {H, E}
d) All of the above
e) None of the above

Question 15. Which of the following functional dependencies is a completely non trivial functional dependency in F+?

a) {A, D} → {D}
b) {E} → {H}
c) {A, H} → {H, E}
d) All of the above
e) None of the above

Question 16. Which of the following functional dependencies is a non trivial functional dependency in F+ but is not completely non trivial?

a) {A, D} → {D}
b) {E} → {C}
c) {A, H} → {H, E}
d) All of the above
e) None of the above

Reminder:

R = {A, B, C, D, E, G, H}

F= {{A} → {D}, {A, E} → {H}, {D, G} → {B, C}, {A, D, G} → {C}, {E} → {C}, {H} → {E}, {H} → {C}}.

Question 17. Which of the following is a superkey of R with F?

a) {A, E, G}
b) {A, E, G, H}
c) {A, B, E, G, H}
d) All of the above
e) None of the above

Question 18. Which of the following is a superkey of R with F?

a) {A, B, E}
b) {A, B, E, C}
c) {A, B, E, C, H}
d) All of the above
e) None of the above

Question 19. Which of the following is a candidate key of R with F?

a) {A, G, H}
b) {A, E, G, H}
c) {A, B, E, G, H}
d) All of the above
e) None of the above

Question 20. Which of the following is a possible primary key of R with F?

a) {A, E, G}
b) {A, E, G, H}
c) {A, B, E, G, H}
d) All of the above
e) None of the above

For the next 5 questions consider the decomposition of R with F above into 4 relations:

R1 = {A,D}, R2={A,E,H}, R3={E,C}, R4={B,C,D,G} (HINT: compare to a 3NF decomposition)

Question 21. Is the decomposition lossless?

a) Yes
b) No

Question 22. Is the decomposition in 2NF?

a) Yes
b) No

Question 23. Is the decomposition in 3NF?

a) Yes
b) No

Question 24. Is the decomposition in BCNF?

a) Yes
b) No

Question 25. Is the decomposition dependency preserving?

a) Yes
b) No

Exercise II. (32 marks) The following 8 questions are structured essay questions. Give your answer **in the space provided in the script.** Points are deducted for unnecessary comments and wrong answers.

Your company, Apasaja Pte Ltd, has been commissioned to implement a micro-blogging system. Consider the following schema.

```
CREATE TABLE user (
        password VARCHAR(24),
        name VARCHAR(24) PRIMARY KEY)
CREATE TABLE message (
        content VARCHAR(140),
        date DATE,
        time TIME,
        user VARCHAR(24) REFERENCES user(name),
        PRIMARY KEY (user, date, time))
CREATE TABLE friend (
        user VARCHAR(24) REFERENCES user(name),
        friend VARCHAR(24) REFERENCES user(name),
        PRIMARY KEY (user, friend))
```

Answer the following queries in the language indicated. Take primary keys and foreign keys into account to simplify queries.

Question 26. (3 marks) (TRC) Print the content of the messages posted by user 'kim1990'.

Question 27. (3 marks) (TRC) Print the name of users who are their own friend.

Question 28. (3 marks) (Algebra) Print the name of users who are their own friend.

Question 29. (3 marks) (Algebra) Print the name of users who have no friend. Do not use Cartesian product and join.

Question 30. (11 marks) (SQL) Print the name of users who have no friend. Give three significantly different answers.

Question 33. (3 marks) (Algebra) Print the name of users who have no friend and have never posted a message. Do not use Cartesian product and join.

Question 34. (3 marks) (Algebra) Print the name of users who have posted some message and have some friend. Do not use Cartesian product and join.

Question 35. (3 marks) (TRC) Print the names of the users who are friends of all friends of 'kim1990'.

Exercise III. (18 marks) The following 5 questions are structured essay questions. Give your answer **in the space provided in the script.** Points are deducted for unnecessary comments and wrong answers.

Consider the following relational scheme with the flowing set of functional dependencies

R= {A, B, C, D, E}

F = {{A, B} → {C}, {C} → {D}, {C} → {E}, {E} → {A}}.

Question 36. (3 marks) What are the candidate keys of R with F?

Question 37. (3 marks) Give a functional dependency in F that violates the BCNF condition?

Question 38. (3 marks) Give a functional dependency in F that violates the 3NF condition?

Question 39. (3 marks) Give a functional dependency in F that violates the 2NF condition?

Question 40. (6 marks) Find a BCNF dependency preserving decomposition of R with F. Just give the result of the decomposition. Do not indicate the steps.

-- END OF PAPER ---