NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING
Final examination for
Semester 1 AY2012/2013

CS2102 – DATABASE SYSTEMS

November 2012 Time Allowed: 2 Hour

INSTRUCTIONS TO CANDIDATES

1. This examination paper contains **THREE (3)** exercises and comprises **TWELVE (12)** 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 penalized.
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
Exercise I (51) OCR		
Exercise II (27)		
Exercise III (22)		
Total (100)		

This is a series of multiple choice questions (questions **1** to **17**) and short essay questions (questions **18** to **25**).
For each **multiple choice question** choose the best answer and report the corresponding choice onto the **OCR form.** Each multiple choice question is worth 3 marks. No mark is deducted for wrong answers.
For each **short essay question** give your answer **in the reserved space in the script.** Points may be deducted for unnecessary comments and wrong answers.

Exercise I. (51 marks) Multiple choice questions. Answer on the OCR form.

Consider the following two self-describing tables. Primary key attributes are underlined.

invoice

number	customer	date	amount
12343	121	24/4/11	123,455
23432	234	1/3/11	3,234
23456	121	12/4/11	12,540
67891	121	1/4/11	1,432
19473	234	11/12/11	555

customer

code	name	address
121	Alexander Grasdorff	12 Clementi Road
234	David Jacques	1 Science Park Drive
233	Peter Ho	3 Boon Lay Street
122	Arun Gadgil	53 Changi Crescent

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

{<X1> | ∃Y1 ∃Z1 (customer(X1, Y1, Z1))}

a) ∅
b) {<121>}
c) {<121>,<234>}
d) {<121>,<233>,<234>,<122>}
e) The query is syntactically incorrect

Question 2. What is the result of the following query?

{<X1> | ∃Y1 ∃Z1 ∃X2 ∃Z2 ∃V2 (customer(X1, Y1, Z1) ∧ invoice(X2, X1, Z2, V2) ∧ Z2 >= '1/4/11')}

a) ∅
b) {<121>}
c) {<121>,<234>}
d) {<121>,<233>,<234>,<122>}
e) The query is syntactically incorrect

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

{<X1> | ∃Y1 ∃Z1 ∃V1 ∃X2 ∃Y2 ∃V2 (invoice(X1, Y1, Z1, V1) ∧ invoice(X2, Y2, Z1, V2))}

a) ∅
b) {<121>}
c) {<121>,<234>}
d) {<121>,<233>,<234>,<122>}
e) The query is syntactically incorrect

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

{<X1> | ∃X1 ∃Y1 ∃Z1 ∀X2 ∀Z2 ∀V2 (customer(X1, Y1, Z1) ∧ (invoice(X2, X1, Z2, V2) ⇒ Z2 >= '1/4/11'))}

a) ∅
b) {<121>}
c) {<121>,<233>,<122>}
d) The query is syntactically incorrect
e) The query is unsafe

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

{<X1> | ∀Y1 ∀Z1 ∀X2 ∀Z2 ∀V2 (customer(X1, Y1, Z1) ∧ (invoice(X2, X1, Z2, V2) ⇒ Z2 >= '1/4/11'))}

a) ∅
b) {<121>}
c) {<121>,<233>,<122>}
d) The query is syntactically incorrect
e) The query is unsafe

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

{<X1> | ∃Y1 ∃Z1 ∀X2 ∀Z2 ∀V2 (customer(X1, Y1, Z1) ∧ (invoice(X2, X1, Z2, V2) ⇒ Z2 >= '1/4/11'))}

a) ∅
b) {<121>}
c) {<121>,<233>,<122>}
d) The query is syntactically incorrect
e) The query is unsafe

Question 7. What is the result of the following query?

{<X1, Z2> | ∃Y1 ∃Z1 ∀X2 ∀V2 (customer(X1, Y1, Z1) ∧ (invoice(X2, X1, Z2, V2) ⇒ Z2 >= '1/4/11'))}

a) ∅
b) {<121>}
c) {<121>,<233>,<122>}
d) The query is syntactically incorrect
e) The query is unsafe

Consider the following relation schema with the following set of functional dependencies.

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

Question 8. Which of the following is a functional dependency in F+?

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

Question 9. Which of the following is a trivial functional dependency in F+?

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

Question 10. Which of the following is a completely non trivial functional dependency in F+?

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

Question 11. Which of the following is a functional dependency in an extended minimal cover of F?

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

Question 12. Which of the following is a functional dependency in an extended minimal cover of F?

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

Question 13. Which of the following is a super key of R with F?

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

Question 14. Which of the following is a candidate key of R with F?

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

Question 15. Which of the following is a candidate key of R with F?

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

Question 16. How many prime attributes are there for R with F?

a) 1
b) 2
c) 3
d) 4
e) 5

Question 17. Is R with F in 3NF?

a) Yes
b) No
c) There is not enough information to answer this question

Exercise II. (27 marks) The following 6 questions are structured essay questions. Give your answer **in the space provided in the script.** Points may be deducted for unnecessary comments, unnecessary long or complicated answers and wrong answers.

Consider the following self-descriptive database schema.

```
CREATE TABLE movie(
title VARCHAR(64) PRIMARY KEY))

CREATE TABLE scene (
movie VARCHAR(64),
name VARCHAR(32),
location VARCHAR(64),
duration NUMBER,
PRIMARY KEY (movie, name),
FOREIGN KEY (movie) REFERENCES movie(title))

CREATE TABLE play (
movie VARCHAR(64),
scene VARCHAR(32),
actor VARCHAR(32),
PRIMARY KEY (movie, scene, actor),
FOREIGN KEY (actor) REFERENCES actor(name),
FOREIGN KEY (movie, scene) REFERENCES scene(movie, name))

CREATE TABLE actor(
name VARCHAR(32) PRIMARY KEY,
dob DATE)
```

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

Question 18. (3 marks) (TRC) Print the titles of movies in which Angelina Jolie is playing.

Question 19. (3 marks) (SQL) Print the names of actors who play in movies in which Angelina Jolie is playing.

Question 20. (3 marks) (Algebra) Print the titles of movies in which Angelina Jolie is playing a scene in Cambodia.

Question 21. (3 marks) (TRC) Print the names of actors who **only** play in movies in which Angelina Jolie is playing.

Question 22. (6 marks) Show that the following two queries are equivalent by transforming one into the other.

$\{ \langle X1 \rangle \mid \exists X1\ \exists X2\ \forall X3\ \forall X4\ \forall X5$
$(actor(X1, X2) \wedge (play(X3, X4, X5) \Rightarrow X1 \langle\rangle X5))\}$

$\{ \langle X1 \rangle \mid \exists X1\ \exists X2$
$(actor(X1, X2) \wedge \neg (\exists X3\ \exists X4\ play(X3, X4, X1)))\}$

Question 23. (9 marks) Translate the above query in English and in SQL.

English

SQL

Exercise III. (22 marks) The following 2 questions are structured essay questions. Give your answer **in the space provided in the script.** Points may be deducted for unnecessary comments and wrong answers.

Consider the relation R(A, B, C, D, E) with the set of functional dependencies F = {{A, B} → {A, B, C, E}, {C} →{C, B}}

Question 24. (6 marks) Prove, using the functional dependencies in F and the Armstrong Axioms only, that {A, C, D} is a superkey. Indicate the axioms used.

Question 25. (16 marks) Normalize (in the best possible normal form that preserves the dependencies) the relation R(A, B, C, D, E) with the set of functional dependencies F = {{A, B} → {A, B, C, E}, {C} →{C, B}}. Show the steps and explain. (Clarity of presentation, rigor and conciseness are also assessed.)

-- END OF PAPER ---