NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2018-2019

CZ2007 – INTRODUCTION TO DATABASES

Nov/Dec 2018 Time Allowed: 2 hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 5 pages.
2. Answer **ALL** questions.
3. This is a closed-book examination.
4. All questions carry equal marks.

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1. (a) Construct an ER diagram corresponding to the following schemas:

researcher (rid, name, birthdate)
journal_paper (jid, paper_title)
write (rid, jid, publication_date)
school (sname, uname)
university (uname, country)
work (rid, sname, uname, start_date, end_date)
project (pid, title, start_date, end_date)
awarded (rid, pid)

(9 marks)

(b) Consider the database of a shopping platform that allows different shops to sell different products to different buyers. No two shops sell the same product. The database has the following schemas:

buyer (bid, bname, points_balance)
buy (bid, pid, date, time)
product (pid, pname, price, sid)
shop (sid, sname, address)

Question No. 1 continues on Page 2

Answer each of the following queries using relational algebra. Clearly describe your intermediate steps.

You may use any of the following operators: σ (selection), Π (projection), ⋈ (natural/theta join), ∪ (union), ∩ (intersection), − (intersection), γ (grouping and aggregation), δ (duplicate elimination), ÷ (division), := (assignment), ρ (rename).

(i) For each of those buyers who bought all the products from shop named "Shopee", find out how much he/she has spent in total in each of the other shops where he/she has purchased products.

(8 marks)

(ii) Find out how much each buyer has spent in each shop. For those shops that a buyer has not purchased anything, the amount spent is zero.

(8 marks)

2. Consider the relation R(A, B, C, D, E, F, G) with the following functional dependencies: A → D, ADG → F, ACE → BD, B → C, C → A, D → G, E → B, EF → AD, F → E, G → F.

(a) Find all the keys of R.

(10 marks)

(b) Give a lossless-join, dependency-preserving BCNF decomposition of R.

(5 marks)

(c) Argue that no 2-attribute subset of {A, B, C, D, E, F, G} is a key for R.

(10 marks)

3. (a) Let R(A, B, C) and S(C, D, E) be two relational schemas. Let q and r be relations (i.e., tables) on schema R; and s be a relation (i.e., a table) on schema S. Convert the following relational algebra queries to SQL.

(i) q − r

(5 marks)

Question No. 3 continues on Page 3

(ii) $\Pi_{A, C}(r) \bowtie \Pi_{C, D}(s)$

(5 marks)

(b) For the following relational schema:

employee (employee-name, street, city)
works (employee-name, company-name, salary)
company (company-name, city)
manages (employee-name, manager-name)

Assume that all people work for at most one company. Give an expression in SQL for each of the following queries:

(i) Find the names of all employees who earn more than the average salary of all employees of their company.

(5 marks)

(ii) Find the names of all employees in the database who live in the same cities and on the same streets as do their managers. Each company has at most one manager, who is also an employee of the same company.

(5 marks)

(c) Consider the following relational schema:

students (name, subject-code, marks)

Someone wants to report average marks grouped by each subject-code, only for those subject-codes in which the average mark is higher than 75. What is wrong with the following SQL query? Also write the correct SQL query.

```
SELECT subject-code, AVG (marks)
FROM students
WHERE AVG (marks) > 75;
```

(5 marks)

4. (a) Consider a "Hospital" database with the following relations.

doctors (doctorID, doctorName)
patients (patientID, patientName)
appointments (doctorID, patientID, date)

The hospital has a policy that the number of appointments for a doctor on any specific date cannot exceed 50. Write an assertion to check the above constraint.

(5 marks)

(b) Consider the following relation storing the employee Ids and salaries.

employee (eID, salary)

Consider the following trigger over this relation.

```
CREATE TRIGGER T1
AFTER INSERT ON employee
REFERENCING NEWTABLE AS new_emp
FOR EACH STATEMENT
UPDATE employee
SET salary = 1.1 * (SELECT MAX (salary) FROM employee)
WHERE ID IN (SELECT ID FROM new_emp)
```

Assume that the relation "employee" has no tuple initially. Suppose that we had inserted the following four rows in that order into the employee table as the result of four separate SQL statements.

1	1000
2	2000
3	3000
4	4000

Show the final database state after trigger execution.

(5 marks)

(c) Consider the following relation:

customer (cust_code, cust_name, cust_country, opening_amt, receive_amt, outstanding_amt)

Question No. 4 continues on Page 5

Consider a view "myclient" as given below.

```
CREATE VIEW myclient (client_name, client_no, outspercent)
AS SELECT  cust_name, cust_code,
                outstanding_amt*100/(opening_amt+receive_amt)
FROM customer
WHERE cust_country = 'USA'
AND  outstanding_amt*100/(opening_amt+receive_amt) > 50;
```

What will be the output of the following SQL query? Justify your answer.

```
UPDATE myclient
SET outspercent = 80
WHERE client_no = 1;
```

(5 marks)

(d) Mention two disadvantages of using indexes over relational tables.

(5 marks)

(e) Convert the following XML document into an equivalent relational format. You can use multiple tables.

```
<customerinfo Cid="1003">
    <name>Robert Shoemaker</name>
    <addr country="Canada">
        <street>845 Kean Street</street>
        <city>Aurora</city>
        <prov-state>Ontario</prov-state>
        <pcode-zip>N8X 7F8</pcode-zip>
    </addr>
    <phone type="work">905-555-7258</phone>
    <phone type="home">416-555-2937</phone>
    <phone type="cell">905-555-8743</phone>
</customerinfo>
```

(5 marks)

END OF PAPER

CZ2007 INTRODUCTION TO DATABASES

Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.