

**NANYANG TECHNOLOGICAL UNIVERSITY****SEMESTER 2 EXAMINATION 2023-2024****SC2207/CZ2007 – INTRODUCTION TO DATABASES**

Apr/May 2024

Time Allowed: 2 hours

**INSTRUCTIONS**

1. This paper contains 4 questions and comprises 6 pages.
  2. Answer **ALL** questions.
  3. This is a closed-book examination.
  4. All questions carry equal marks.
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1. Consider a database comprising five tables as shown. They record information about students, their project groups and internship. Keys are underlined.

STUDENT(sID, YearOfStudy, School, CGPA)PROJECT\_GROUP(courseID, year, semester, groupID, sID)COMPANY(aID, contactPerson, address, country)INTERNSHIP(uID, aID, salary, startDate, endDate, country)TAKEUP\_INTERNSHIP(sID, uID)

Answer the following queries using Relational Algebra.

- (a) Find pairs of students who were in the same project groups for at least 3 different courses.

(12 marks)

- (b) Who are those students in Q1(a) whose only internship(s) that they participated are from the same company, have the same salary, start date and end date, and are in the same country?

(13 marks)

2. (a) Consider a relation R(A, B, C, D, E) with the following FDs:

$$A \rightarrow B, BC \rightarrow D, BD \rightarrow A, CD \rightarrow E, AB \rightarrow D.$$

Verify whether R is in BCNF. If R is not in BCNF, apply a BCNF decomposition on R, and then verify whether your BCNF decomposition preserves all functional dependencies.

(13 marks)

- (b) You are given the following schemas: A(H, Z), B(X, H), C(M, K, X), D(M, N, H), E(M, P), F(W, Y), G(H, L, R), S(W, M), U(H, M). Keys are underlined.

Re-construct one possible ER diagram that maps to these schemas by drawing suitable shapes around the letters in Fig. 2.

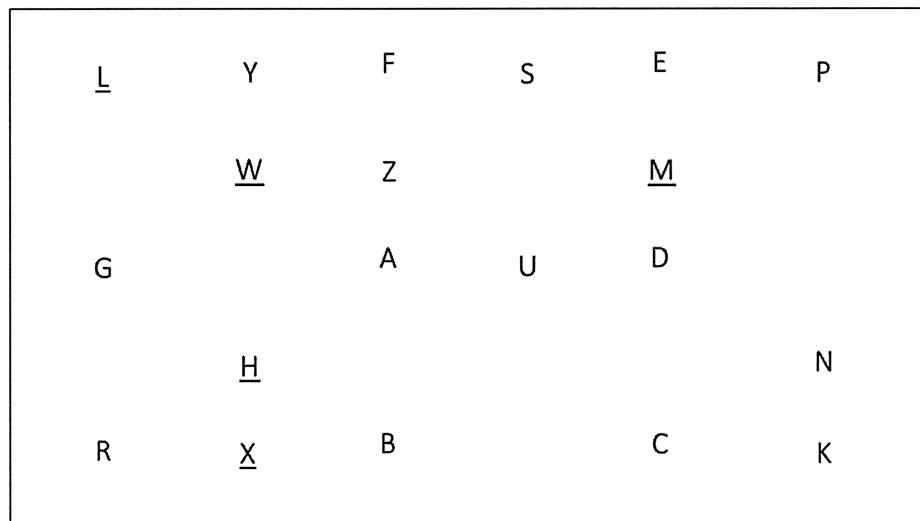


Figure Q2

The shapes may represent attributes (ovals), entity sets (rectangles), or relationships (diamonds or triangles). Connect these shapes via lines to form a ER diagram. Indicate arrows for many-to-one or one-to-one relationships. Add additional relationships whenever necessary.

If you think certain schema cannot be re-constructed back into a ER diagram artifact, give suitable reasons as to why this may be so.

(12 marks)

3. Consider the following database containing four base relations (primary keys are underlined), and a view. The four base relations are given below.

<b>Customer</b>		
<u>cid</u>	<b>name</b>	<b>address</b>
1	Anna	Capitol Hill
2	James	University
3	Charlie	View Ridge

<b>Owns</b>	
<u>cid</u>	<u>aid</u>
1	1
1	2
2	1
2	2
3	3
3	4

<b>Account</b>		
<u>aid</u>	<b>amount</b>	<b>type</b>
1	900	Checking
2	3000	Saving
3	900	Checking
4	100	Saving

<b>ActivityLog</b>					
<u>opid</u>	<u>cid</u>	<b>optype</b>	<b>aid1</b>	<b>aid2</b>	<b>amount</b>
101	1	deposit	1	NULL	200
102	2	withdrawal	1	NULL	200
103	3	transfer	3	4	100

- Attribute **cid** is the customer id, attribute **aid** is the account id, and attribute **opid** is the id of an activity log. Attribute **Account.amount** is the balance amount of each account. Attribute **Account.type** is the type of an account, which can be checking or saving.
- Attribute **optype** is the type of an activity, which can be deposit, withdrawal, or transfer. When the type is deposit, the amount of money in attribute **ActivityLog.amount** is deposited into account **aid1**; When the type is withdrawal, the amount of money in attribute **ActivityLog.amount** is withdrawn from account **aid1**; When the type is transfer, the amount of money in attribute **ActivityLog.amount** is transferred from account **aid1** to account **aid2**.
- Attribute **Owns.cid** is a foreign key that references **Customer.cid**.
- Attribute **Owns.aid** is a foreign key that references **Account.aid**.
- Attribute **ActivityLog.cid** is a foreign key that references **Customer.cid**.
- Attribute **ActivityLog.aid1** and **ActivityLog.aid2** are foreign keys that reference **Account.aid**.

The view is described by the SQL statement that created it as follows, and it is for premier customers.

```
CREATE VIEW PremierCustomer AS
SELECT DISTINCT C.cid, C.name
FROM Customer C, Owns O, Account A
WHERE C.cid = O.cid AND O.aid = A.aid AND A.amount > 2000
```

Question No. 3 continues on Page 4

- (a) Answer each of the following queries with a single SQL statement.
- (i) Find the names and addresses of premier customers who own the accounts with the largest amount of balance. (5 marks)
- (ii) Find names of customers who owns at least TWO “checking” account and ONE “Saving” account. (5 marks)
- (iii) Find names of customers who have never transferred any money to others’ accounts. (5 marks)
- (b) What is the output of the following queries? Draw the relation instance produced by each query in the form of a table. Include the table header to clearly show the schema of the relation. The order of the tuples in the table does not matter.
- (i) `SELECT count(*) as total_activity  
FROM Account A2, ActivityLog L2  
WHERE A2.aid = L2.aid1 OR A2.aid = L2.aid2  
GROUP BY A2.aid`  
(5 marks)
- (ii) `SELECT C.name  
FROM Account A, ActivityLog L, Customer C, Owns O  
WHERE (A.aid = L.aid1 OR A.aid = L.aid2)  
AND A.aid = O.aid AND O.cid = C.cid  
GROUP BY C.name, A.aid  
HAVING count(*) >=  
ALL (SELECT count(*)  
FROM Account A2, ActivityLog L2  
WHERE A2.aid = L2.aid1 OR A2.aid = L2.aid2  
GROUP BY A2.aid)`  
(5 marks)

4. (a) Explain the differences of views, materialized views, and temporary views as well as their pros and cons. (4 marks)

- (b) For the database schema in Q3, create SQL triggers for the following constraint: Table ActivityLog should be consistent with the amount in Table Account. Triggers should be able to maintain the amount in Table Account in the presence of the insertion, deletion and updates of records in Table ActivityLog. For example,

- If a record of optype deposit is inserted into Table ActivityLog, the amount should be added to the amount of account aid1 in Table Account;
- If a record of optype withdrawal is inserted into Table ActivityLog, the amount should be reduced from the amount of account aid1 in Table Account;
- If a record of optype transfer is inserted into Table ActivityLog, the amount should be added to the amount of account aid2 in Table Account, and reduced from the amount of the account aid1 in Table Account.

Write all the necessary triggers to implement this constraint.

(8 marks)

- (c) Consider relation Purchase (PID, CNO, Pname, Pno, Date, Quantity, Price).

- (i) If there is an index on attribute Price, will the index speed up finding the product Pname with the highest price in the table? Will the index speed up finding the purchase with the highest amount (which is the product of Quantity and Price)? (2 marks)

- (ii) Give one negative effect of building indexes for a database table.

(2 marks)

- (iii) Give a composite index for relation Purchase and an SQL query that the index can speed up. (3 marks)

Question Q4 continues on Page 6

- (d) Consider the following scenario: Each tweet has a tweet ID, the user ID who posted the tweet, the time of posting the tweet, as well as the textual content of the tweet. Each twitter user has a user ID, name, age, and sex.
- (i) Design a relational database schema for storing the data.  
(2 marks)
- (ii) Design an XML DTD for the data in the database designed in Q4(d)(i).  
(4 marks)

END OF PAPER



**SC2207 INTRODUCTION TO DATABASES**  
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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.