

香港中文大學  
The Chinese University of Hong Kong

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Midterm Examination 2008 Fall

Course Code & Title : ..... **CSC 3170 Introduction to Database Systems** .....

Time allowed : ..... **1** ..... hours ..... **30** ..... minutes

Student I.D. No. : .....

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Please write your answers in the space provided. Use the back of the pages if necessary.

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**Problem 1.** Consider the following tables in a library system:

AUTHOR(*a-id, a-name*)  
BOOK (*b-id, b-title*)  
WRITES (*a-id, b-id*)  
USER (*u-id, u-name*)  
BORROW (*u-id, b-id, date*)

Write SQL queries for the following tasks.

(a) Find the names of users that have borrowed at least a book written by Dan Brown.

**Answer:**

```
SELECT u-name FROM AUTHOR A, WRITES W, USER U, BORROW BR
WHERE A.a-id = W.a-id AND BR.b-id = B.b-id AND BR.u-id = U.u-id AND A.a-name = 'Dan
Brown'
```

(b) For every user, print her/his name, and the number of distinct books s/he has borrowed.

**Answer:**

```
SELECT U.u-name, COUNT(DISTINCT BR.b-id)
FROM USER U, BORROW BR
WHERE U.u-id = BR.u-id
GROUP BY U.u-id, U.u-name
```

(c) Find the name of the user that has borrowed the largest number of books.

**Answer:**

```
WITH STAT(u-name, cnt) AS
SELECT U.u-name, COUNT(DISTINCT BR.b-id)
FROM USER U, BORROW BR
WHERE U.u-id = BR.u-id
GROUP BY U.u-id, U.u-name
SELECT u-name FROM STAT WHERE cnt = SELECT MAX(cnt) FROM STAT
```

(d) Find the titles of the books that have been borrowed by at least 100 different users.

**Answer:**

```
SELECT B.b-title
FROM BOOK B, BORROW BR
WHERE B.b-id = BR.b-id
GROUP BY B.b-id, B.b-title
HAVING COUNT(DISTINCT BR.u-id) >= 100
```

(e) Find the books borrowed by users who have borrowed at least one book by Dan Brown. Note that books by Dan Brown should not be displayed.

**Answer:**

```
SELECT b-title FROM BOOK B1, BORROW BR1, USER U1
WHERE B1.b-id = BR1.b-id AND BR1.u-id = U1.u-id
AND U1.u-id IN
(SELECT U2.u-id FROM AUTHOR A2, BOOK B2, WRITES W2, USER U2, BORROW BR2
WHERE A2.a-id = W2.a-id AND B2.b-id = W2.b-id AND BR2.b-id = B2.b-id AND BR2.u-id =
U2.u-id AND A2.a-name = 'Dan Brown')
AND B1.b-title NOT IN
(SELECT U3.b-title FROM AUTHOR A3, WRITES W3
WHERE A3.a-id = W3.a-id AND A3.a-name = 'Dan Brown')
```

**Problem 2.** Consider table  $T(A, B, C)$  with functional dependencies

$$A \rightarrow B$$

$$B \rightarrow A$$

$$B \rightarrow C$$

(i) Compute the closure of  $A$ .

**Answer:**

$$A^+ = \{A, B, C\}.$$

(i) Find all the candidate keys of  $T$ .

**Answer:**

$A$  and  $B$ .

(ii) List all the non-trivial functional dependencies that hold on  $T$ , except those already given.

**Answer:**

$$A \rightarrow C, AB \rightarrow C, AC \rightarrow B, BC \rightarrow A.$$

(iii) Is  $T$  in BCNF? Why? (Failure to give reasons gets no mark.)

**Answer:**

Yes, because every non-trivial functional dependency contains a candidate key on the left.

(iv) Is it legal to decompose  $T$  into  $T_1(A, C)$  and  $T_2(B, C)$ ? Why? (Failure to give reasons gets no mark.)

**Answer:**

No, because the common attribute  $C$  is not the key of  $T_1$  nor  $T_2$ .

**Problem 3.** Consider table  $T(A, B, C, D, E)$  with functional dependencies

$$D \rightarrow E$$

$$AB \rightarrow D$$

$$C \rightarrow B$$

$$B \rightarrow C$$

$$CD \rightarrow A$$

(i)  $T$  has 4 candidate keys. Find all of them.

**Answer:**

$AB$ ,  $AC$ ,  $CD$ , and  $BD$ .

(ii) Give a relational algebra query whose result can be used to decide whether  $D \rightarrow E$  holds in  $T$ . You need to explain how to make the decision based on the result. The first line of the query has been provided for you:

$$T' \leftarrow T$$

Note: This duplicates  $T$  to an identical table named  $T'$ , which can be used in the rest part of the query.

**Answer:**

$$\sigma_{T.D=T'.D \wedge T.E \neq T'.E}(T \times T').$$

If the query returns anything, the functional dependency does not hold. Otherwise, it holds.

(iii) Decompose  $T$  into BCNF tables.

**Answer:**

One possible answer:  $DE$ ,  $ABD$ ,  $BC$ ,  $AB$ .

**-End-**