Database Systems: Homework 1 Key

Due 18 September, 2013

Team: _____

1. **(2 pts each)** Consider the two tables $T1$ and $T2$. Show the results of the following relational algebra operations:

Table $T1$

P	Q	R
10	a	5
15	b	8
25	a	6

Table $T2$

A	B	C
10	b	6
25	c	3
10	b	5

(a) $T1 \bowtie_{T1.P=T2.A} T2$

P	Q	R	A	B	C
10	a	5	10	b	6
10	a	5	10	b	5
25	a	6	25	c	3

(b) $T1 \bowtie_{T1.Q=T2.B} T2$

P	Q	R	A	B	C
15	b	8	10	b	6
15	b	8	10	b	5

(c) $T1 \rtimes_{T1.P=T2.A} T2$

P	Q	R	A	B	C
10	a	5	10	b	6
10	a	5	10	b	5
15	b	8	ω	ω	ω
25	a	6	25	c	3

(d) $T1 \bowtie\!\!\!\subset_{T1.Q=T2.B} T2$

P	Q	R	A	B	C
15	b	8	10	b	6
ω	ω	ω	25	c	3
15	b	8	10	b	5

(e) $T1 \cup T2$

P	Q	R
10	a	5
15	b	8
25	a	6
10	b	6
25	c	3
10	b	5

(f) $T1 \bowtie_{T1.P=T2.A \text{ AND } T1.R=T2.C} T2$

P	Q	R	A	B	C
10	a	5	10	b	5

2. Refer to figure 4.6, a schema diagram for a library database, for these questions:

   (a) **(6 pts)** Write the SQL DDL statements to define this database. Include appropriate domains, constraints and referential triggered actions.

```
CREATE TABLE Book (
   Book_id          Int           PRIMARY KEY,
   Title            Varchar(200),
   Publisher_name   Varchar(200),
   FOREIGN KEY (Publisher_name) REFERENCES Publisher(Name)
      ON DELETE SET NULL   ON UPDATE CASCADE
);

CREATE TABLE Book_Authors (
   Book_id       Int               NOT NULL,
   Author_name   Varchar(200)      NOT NULL,
   PRIMARY KEY (Book_id, Author_name),
   FOREIGN KEY (Book_id) REFERENCES Book(Book_id)
      ON DELETE CASCADE   ON UPDATE CASCADE
);

CREATE TABLE Publisher (
   Name      Varchar(200)     PRIMARY KEY,
   Address   Varchar(400),
   Phone     Decimal(20)
);

CREATE TABLE Book_Copies (
   Book_id       Int       NOT NULL,
   Branch_id     Char(4)   NOT NULL,
   No_of_copies   Int       DEFAULT 1,
   PRIMARY KEY (Book_id, Branch_id),
   FOREIGN KEY (Book_id) REFERENCES Book(Book_id)
      ON DELETE CASCADE   ON UPDATE CASCADE,
   FOREIGN KEY (Branch_id) REFERENCES Library_Branch(Branch_id)
      ON DELETE CASCADE   ON UPDATE CASCADE
);

CREATE TABLE Book_Loans (
   Book_id     Int          NOT NULL,
   Branch_id   Char(4)      NOT NULL,
   Card_no     Int          NOT NULL,
   Date_out    Date,
   Due_date    Date,
   PRIMARY KEY (Book_id, Branch_id, Card_no),
```

```
   FOREIGN KEY (Book_id) REFERENCES Book(Book_id)
      ON DELETE RESTRICT   ON UPDATE CASCADE,
   FOREIGN KEY (Branch_id) REFERENCES Library_Branch(Branch_id)
      ON DELETE RESTRICT   ON UPDATE CASCADE,
   FOREIGN KEY (Card_no) REFERENCES Borrower(Card_no)
      ON DELETE RESTRICT   ON UPDATE CASCADE
);

CREATE TABLE Library_Branch (
   Branch_id     Char(4)         PRIMARY KEY,
   Branch_name   Varchar(200)    NOT NULL,
   Address       Varchar(400)
);

CREATE TABLE Borrower (
   Card_no       Int            PRIMARY KEY,
   Name          Varchar(200)   NOT NULL,
   Address       Varchar(400),
   Phone         Decimal(20)
);
```

(b) **(4 pts)** Write the SQL DML statement to insert a new borrower, ⟨328820001, ‘‘Marten Fisher’’, ‘‘123 Fake St, Springfield’’, 406 582 2400⟩, in the database.

```
INSERT INTO Borrower
VALUES (328820001, 'Martin Fisher',
        '123 Fake St, Springfield', 4065822400);
```

(c) **(4 pts)** The Bozeman branch has acquired a second copy of the book *Here Comes a Candle*. Write the SQL to update the database to increase the number of copies for that book by one.

```
UPDATE Book_Copies SET No_of_copies = No_of_copies+1
WHERE Book_id IN (
   SELECT Book_id FROM Book WHERE Title='Here Comes a Candle'
) AND Branch_id IN (
   SELECT Branch_id FROM Library_Branch WHERE Branch_name='Bozeman'
);
```

3. **(4 pts each)** Refer to figure 3.5, the schema diagram for the COMPANY database, for these questions:

(a) Write the SQL query to retrieve the names of all employees who work in the department that has the employee with the highest salary among all employees.

```
SELECT Fname, Minit, Lname
FROM   Employee
WHERE  Dno = (
   SELECT Dno
   FROM   Employee
   WHERE  Salary = (
      SELECT max(Salary)
      FROM   Employee
   )
);
```

(b) Write the SQL query to retrieve the names of all employees whose supervisor's supervisor has '888665555' for Ssn.

```
SELECT Fname, Minit, Lname
FROM   Employee
WHERE  Super_ssn IN (
   SELECT Ssn FROM Employee WHERE Super_ssn = 888665555
);
```

(c) Write the SQL query to retrieve the names of employees who make at least $10,000 more than the employee who is paid the least in the company.

```
SELECT Fname, Minit, Lname
FROM   Employee
WHERE  Salary >= 10000+(SELECT min(Salary) FROM Employee);
```

4. **(4 pts each)** Refer again to figure 4.6, this time give relational algebra expressions for the following queries:

(a) How many copies of the book titled *The Lost Tribe* are owned by the library branch whose name is 'Sharpstown'?

$$\begin{aligned} \text{Sharps\_id} &\leftarrow \pi_{\text{Branch\_id}}(\sigma_{\text{Branch\_name}='\text{Sharpstown}'}(\text{Library\_Branch})) \\ \text{Tribe\_id} &\leftarrow \pi_{\text{Book\_id}}(\sigma_{\text{Title}='\text{The Lost Tribe}'}(\text{Book})) \\ \text{Answer} &\leftarrow \pi_{\text{No\_of\_copies}}(\text{Book\_Copies} * \text{Sharps\_id} * \text{Tribe\_id}) \end{aligned}$$

-or-

$$\begin{aligned} \text{Answer} \leftarrow \pi_{\text{No\_of\_copies}}(\sigma_{\text{Branch\_name}='\text{Sharpstown}' \wedge \text{Title}='\text{The Lost Tribe}'}(\\ \text{Book\_Copies} * \text{Library\_Branch} * \text{Book})) \end{aligned}$$

(b) Retrieve the names of all borrowers who do not have any books checked out.

$$\begin{aligned} \text{None\_id} &\leftarrow \pi_{\text{Card\_no}}(\text{Borrower}) - \pi_{\text{Card\_no}}(\text{Book\_Loans}) \\ \text{Answer} &\leftarrow \pi_{\text{Name}}(\text{Borrower} * \text{None\_id}) \end{aligned}$$

(c) Retrieve the names, addresses, and number of books checked out for all borrowers who have more than five books checked out.

$$\begin{aligned} \text{Loan\_counts} &\leftarrow \rho_{(\text{Card\_no,Book\_count})}({}_{\text{Card\_no}}\Im_{\text{Count(Book\_id)}}(\text{Book\_Loans})) \\ \text{Big\_borrowers} &\leftarrow \sigma_{\text{Book\_count}>5}(\text{Loan\_counts}) \\ \text{Answer} &\leftarrow \pi_{\text{Name,Address,Book\_count}}(\text{Big\_borrowers} * \text{Borrower}) \end{aligned}$$

5. **(6 pts)** In relational models, primary keys based on existing, meaningful attributes of the tuples are known as *natural keys*. Some database designers prefer to add an extra attribute that doesn't model anything about the miniworld; it is specifically generated solely to be a primary key. These are called *surrogate keys*. Discuss the advantages and disadvantages of both approaches.

Figure 4.6

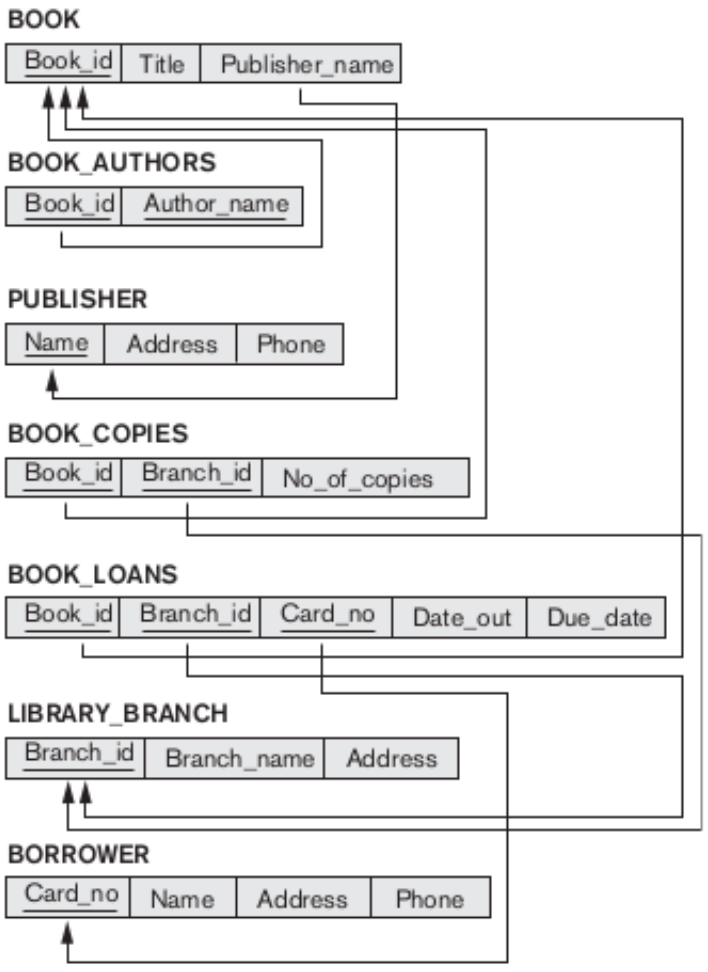

Figure 4.6
A relational database schema for a LIBRARY database.

Figure 3.5

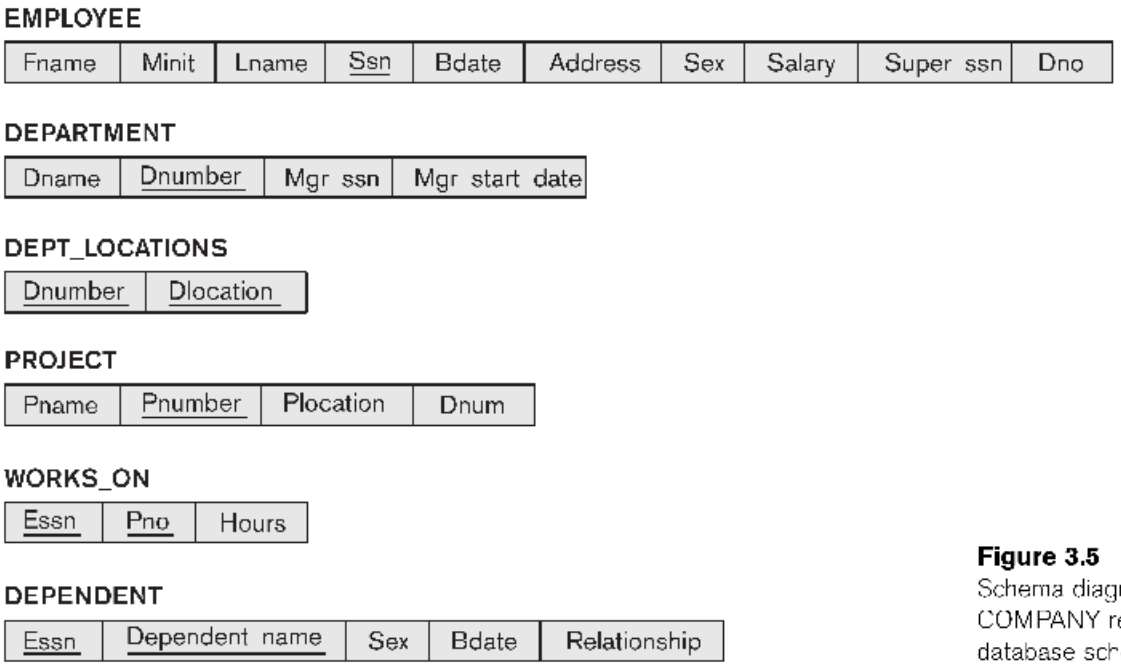

Figure 3.5
Schema diagram for the COMPANY relational database schema.