School of Information Technology and Electrical Engineering (ITEE), UQ

Tutorial 2

Question 1 Suppose that each of the following operations is applied directly to the database in Figure 1. Discuss all integrity constraints violated by each operation, if any, given the schema in Figure 2.

EMPLOYEE

Fname	Minit	Lname	SSN	BDate	Address	Sex	Salary	SuperSSN	Dno
John	B	Smith	123456789	9-Jan-55	731 Fonden	M	3000	333445555	5
Franklin	T	Wong	333445555	8-Dec-45	638 Voss	M	4000	888665555	5
Alicia	J	Zeleya	999887777	19-Jul-58	3321 Castle	F	2500	987654321	4
Jennifer	S	Wallace	987654321	20-Jun-31	291 Berry	F	4300	888665555	4
Ramesh	K	Narayan	666884444	15-Sep-52	975 Fire Oak	M	3800	333445555	5
Joyce	A	English	453453453	31-Jul-62	5631 Rice	F	2500	333445555	5
Ahmad	V	Jabbar	987987987	29-Mar-59	980 Dallas	M	2500	987654321	4
James	E	Borg	888665555	10-Nov-27	450 Stone	M	5500	null	1

WORKS_ON

ESSN	PNo	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40
453453453	1	20
453453453	2	20
333445555	2	10
333445555	3	10
333445555	10	10
333445555	20	10
999887777	30	30
999887777	10	10
987987987	10	35
987987987	30	5
987654321	30	20
987987987	20	15
888665555	20	null

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

DEPARTMENT

Dname	Dnumber	MgrSSN	MgrStartDate
Research	5	333445555	22-May-78
Admin	4	987654321	1-Jan-85
Headquarters	1	888665555	19-Jun-71

PROJECT

PName	Pnumber	PLocation	DNum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganisation	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

ESSN	DepName	Sex	BDate	Relationship
333445555	Alice	F	5-Apr-76	Daughter
333445555	Theodore	M	25-Oct-73	Son
333445555	Joy	F	3-May-48	Spouse
987654321	Abner	M	29-Feb-32	Spouse
123456789	Michael	M	1-Jan-78	Son
123456789	Alice	F	31-Dec-78	Daughter
123456789	Elizabeth	F	5-May-57	Spouse

Figure 1: Database

INFS2200/7903 – Relational Database Systems

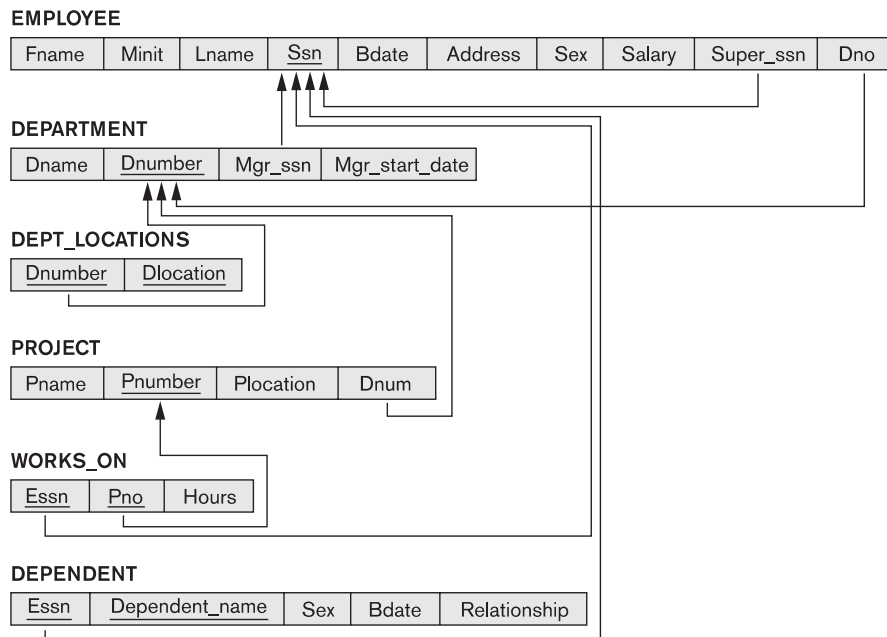School of Information Technology and Electrical Engineering (ITEE), UQ

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Figure 2: Schema Diagram

A. Insert <'Robert', 'F', 'Scott', '943775543', '21-JUN-42', '2365 Newcastle Rd, Bellaire, TX', 'M', 58000, '888665555', 1 > into EMPLOYEE.

B. Insert < 'ProductA', 4, 'Bellaire', 2 > into PROJECT.

C. Insert < 'Production', 4, '943775543', '01-OCT-88' > into DEPARTMENT.

D. Insert < '677678989', null, '40.0' > into WORKS_ON

E. Insert < '453453453', 'John', 'M', '12-DEC-60', 'SPOUSE' > into DEPENDENT.

F. Delete the WORKS_ON tuples with ESSN = '333445555'.

G. Delete the EMPLOYEE tuple with SSN = '987654321'.

H. Delete the PROJECT tuple with PNAME = 'ProductX'.

I. Modify the MGRSSN and MGRSTARTDATE of the DEPARTMENT tuple with DNUMBER = 5 to '123456789' and '01-OCT-88', respectively.

J. Modify the SUPERSSN attribute of the EMPLOYEE tuple with SSN = '999887777' to '943775543'.

K. Modify the HOURS attribute of the WORKS_ON tuple with ESSN = '999887777' and PNO = 10 to '5.0'.

Question 2 Consider the following relational schema. An employee can work in more than one department; the pcttime field of the Works relation shows the percentage of time that a given employee works in a given department.

Emp (<u>eid: integer</u>, ename: string, age: integer, salary: real)

Dept (<u>did: integer</u>, dname: string, budget: real, managerid: integer)

Works (<u>eid: integer, did: integer</u>, pcttime: integer)

A. Give an example of a foreign key constraint that involves the Dept relation. What are the options for enforcing this constraint when a user attempts to delete a Dept tuple?

B. Write the SQL statements required to create the above relations, including appropriate versions of all primary and foreign key integrity constraints.

C. Define the Dept relation in SQL so that every department is guaranteed to have a manager.

D. Given the referential integrity constraints you chose for this schema, explain what happens when an SQL statement that deletes the Toy department is executed.

E. Define a table constraint on Emp that will ensure that every employee makes at least $10,000.

F. Define an assertion on Dept that will ensure that all managers have age > *30*.

G. Define an assertion that will ensure that the total percentage of all appointments for an employee is under 100%.

H. Define an assertion that will ensure that the manager must always have a higher salary than any employee that he or she manages.

Answers for Question 1 are given below:

A. No constraint violations.

B. Violates referential integrity because DNUM = 2 and there is no tuple in the DEPARTMENT relation with DNUMBER=2.

C. Violates both key constraint and referential integrity:

    1. Key constraint violation because there already exists a DEPARTMENT tuple with DNUMBER=4.

    2. Referential integrity violation because MGRSSN = '943775543' and there is no tuple in the EMPLOYEE relation with SSN = '943775543'.

D. Violates both entity integrity and referential integrity:

    1. Entity integrity violation because PNO, which is part of the primary key of WORKS_ON, is null.

    2. Referential integrity violation because ESSN ='677678989' and there is no tuple in the EMPLOYEE relation with SSN ='677678989'.

E. No constraint violations.

F. No constraint violations.

G. Violates referential integrity because several tuples exist in the WORKS_ON, DEPENDENT, DEPARTMENT, and EMPLOYEE relations that reference the tuple being deleted from EMPLOYEE.

H. Violates referential integrity because two tuples exist in the WORKS_ON relations that reference the tuple being deleted from PROJECT.

I. No constraint violations.

J. Violates referential integrity because the new value of SUPERSSN = '943775543' and there is no tuple in the EMPLOYEE relation with SSN = '943775543'.

K. No constraint violations.

Note: In questions A, C, E and I, if the domain of BDATE or MGRSTARTDATE was given to be in a certain date format e.g. 01-10-1988, then this could be a domain constraint violation.

Answers for Question 2 are given below:

A. Consider the following example. It is natural to require that the did field of Works should be a foreign key and refer to Dept.

```
CREATE TABLE Works (eid INTEGER,
            did INTEGER,
            pcttime INTEGER,
            PRIMARY KEY (eid, did),
            FOREIGN KEY (did) REFERENCES Dept);
```

When a user attempts to delete a Dept tuple, there are four options (Assume that we ignore the primary key constraint):
- Also delete all Works tuples that refer to it.
- Disallow the deletion of the Dept tuple if some Works tuple refers to it.
- For every Works tuple that refers to it, set the *did* field to the *did* of some (existing) 'default' department.
- For every Works tuple that refers to it, set the *did* field to null.

B.
```
CREATE TABLE Emp (eid INTEGER,
            ename CHAR(10),
            age INTEGER,
            salary REAL,
            PRIMARY KEY (eid));
```

```
CREATE TABLE Dept (did INTEGER,
            dname CHAR(10),
            budget REAL,
            managerid INTEGER ,
            PRIMARY KEY (did),
            FOREIGN KEY (managerid) REFERENCES Emp,
            ON DELETE SET NULL);
```

```
CREATE TABLE Works (eid INTEGER,
            did INTEGER,
            pcttime INTEGER,
            PRIMARY KEY (eid, did),
            FOREIGN KEY (did) REFERENCES Dept,
            FOREIGN KEY (eid) REFERENCES Emp,
            ON DELETE CASCADE);
```

C.
```
CREATE TABLE Dept (did INTEGER,
            dname CHAR(10),
            budget REAL,
            managerid INTEGER NOT NULL,
            PRIMARY KEY (did),
            FOREIGN KEY (managerid) REFERENCES Emp);
```

D. The did field in the Works relation is a foreign key and references the Dept relation. This is the referential integrity constraint chosen. By adding the action ON DELETE CASCADE to this, when a Dept record is deleted, the Works record associated with that department is also deleted.

The query works as follows: The Dept relation is searched for a record with dname = 'Toy' and that record is deleted. The *did* field of that record is then used to search in the Works relation for records with a matching *did* value. All such records are then deleted from the Works relation.

E. CREATE TABLE Emp (eid INTEGER,
                ename CHAR(10),
                age INTEGER,
                salary REAL,
                PRIMARY KEY (eid),
                CHECK (salary >= 10000));

F. CREATE ASSERTION ManagerAge
                CHECK (NOT EXISTS (
                SELECT *
                FROM Emp E, Dept D
                WHERE E.eid = D.managerid
                AND E.age <= 30));

G. CREATE ASSERTION Under100
                CHECK (NOT EXISTS (
                SELECT *
                FROM Works
                GROUP BY eid
                HAVING SUM(pcttime) > 100));

H. CREATE ASSERTION ManagerHigherSalary
                CHECK (NOT EXISTS (
                SELECT *
                FROM Emp E, Emp M, Works W, Dept D
                WHERE E.eid = W.eid
                AND   W.did = D.did
                AND   D.managerid = M.eid
                AND   E.salary >= M.salary));