School: Computer Science
Institution: University of Windsor
Term: Winter 2019
Course: 03-60-315-1 : Database Management Systems
Instructor: Dr. C. I. Ezeife
Assignment #2 Solution: Total: 50 marks
Handed Out:Thurs. Jan. 24, 2019; Due: Thurs Feb. 14, 2019

Objective of Assignment: To test on knowledge and design of relational model constraints, relational database schemas, functional dependencies and normalization of relational databases.

Scope: Assignment covers materials from Chapters 5 and 14 of book discussed in class.

Electronic Assignment Submission: Done through http://blackboard.uwindsor.ca

Marking Sheme : The mark for each of the questions is indicated beside each question.

Academic Integrity Statement: Remember to submit only work that is yours and include the following confidentiality agreement and statement at the beginning of your assignment.

CONFIDENTIALITY AGREEMENT & STATEMENT OF HONESTY

I confirm that I will keep the content of this assignment/examination confidential.
I confirm that I have not received any unauthorized assistance in preparing for or doing this assignment/examination. I confirm knowing that a mark of 0 may be assigned for copied work.

_____ _____
Student Signature Student Name (please print)

_____ _____
Student I.D. Number Date

Marking Scheme : The mark for each question and sub question is shown with the question below. Place your solutions in tables where possible.

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Question	Mark
1	/20
2	/10
3	/10
4	/10
Total	/50

CHAPTER 5: THE RELATIONAL DATA MODEL AND RELATIONAL DATABASE CONSTRAINTS

1. (total marks 20) Given the same simple Customer-Subscribesto_Phonecompany database schema you worked on in Assignment 1, which contains three files describing information about telephone company subscribers as follows:

   Customer (SSN: integer, CName: string, Caddress: string, balance: real)
   Subscribesto (SSN: integer, CompId: string, phonetype: string, month: string, billamt: real)
   PhoneCompany (CompId: string, CompName: string, Address: string, Numproducts:integer)

   Note : SSN, CName, Caddress and balance stand for the customer's social security number, name, address and phone bill balance owing respectively. Also, CompId, phonetype, month and billamt stand for the phone company identifier, the phone type the customer subscribes to, the month of subscription and the phone bill amount for that month. The rest of the attributes are for the company's name, their address and the number of phone products they provide to customers.

   Assume that an update is to be made to this database to enter information about a new PhoneCompany not yet in the database that an existing Customer has now switched to (replacing the customer's old PhoneCompany). Answer the following questions on what specific relations, attributes and operations (eg. insert, modify, delete) that need to be done for this update to be implemented in this database.

   Provide your answers both in descriptive sentence and using the formal database operations of INSERT, MODIFY, DELETE as used in Chapter 5 of book with specific attributes and relations when possible. An example formal insert of a customer record into the Customer table is:
   INSERT < SSN, CName, Caddress, balance> into Customer; // for new Customer record
   And an example descriptive sentence is:
   i). do an insert operation for a new customer record into the Customer table.

   (a) Give the set of needed insert, modify or delete operations for this update.
   5 marks
   (b) What types of constraints (explain using attributes, eg SSN of relevant files) would you expect to check for this update to be done? 5 marks
   (c) Which of these constraints are key, entity integrity, and referential integrity constraints and which are not? 5 marks
   (d) Specify all the referential integrity (foreign key) constraints on this database.
   5 marks

   (Total for que 1 is 20 marks)

Solution:

Question	Answers

a. Give the operations for this update.
 	
5 marks
	One possible set of operations for the given update is the following:
	i. Insert operation into PhoneCompany for the new PhoneCompany record
	ii. Modify operation in Subscribeto for the existing SSN and to change the CompId, phonetype, month and billamt to the existing new Company's that the existing customer is now subscribing to.
	These operations can be specified in English (not SQL) as follows:
	INSERT < CompId, CompName, Address, Numproducts > into PhoneCompany; // for new PhoneCompany record
	MODIFY the Subscribeto tuple of the existing SSN with the condition:
	(Subscripeto.CompId = given new CompId,
	Subscripeto.phonetype = given new phonetype,
	Subscripeto.month = given new month,
	Subscripeto.billamt = given new billamt);

b. What types of constraints would you expect to check? 5 marks	We would check that with the first INSERT operation into the table PhoneCompany, that the CompId assigned to the new PhoneCompany does not already exist (key constraint). With the second MODIFY instruction, we would check that the CompId in Subscribeto we are writing is already an existing CompId (foreign key constraint).
c. Which of these constraints are key, entity integrity, and referential integrity constraints and which are not? 5 marks	The INSERT operations into PhoneCompany will check all the key, entity integrity, and referential integrity constraints for the relations. The MODIFY operation in Subscribeto will also check all the key, entity integrity, and referential integrity constraints for the relation
d. Specify all the referential integrity constraints on this database. 5 marks	We will write a referential integrity constraint as R.A --> S (or R.(X) --> T) whenever attribute A (or the set of attributes X) of relation R form a foreign key that references the primary key of relation S (or T). Subscribeto.SSN --> Customer Subscribeto.CompId --> CompId

2. (total marks 10) Using your own Customer-Subscribesto_Phonecompany database instance from assignment 1, login to the SQL query processor on our cs server, called Oracle Sqlplus to create the three database table and insert the tuples in your database state with the following sequence of instructions. Note that this exercise is to get you beginning to connect to SQLplus while preparing to learn full SQL language syntax in Chapters 6 and 7. You will be given the instructions to use now. Show the result of this exercise through a script file you will attach.

(Total for que 2 is 10 marks)

i. First connect to our cs.uwindsor.ca through either SSH client or NoMachine
ii. Then create a script file to capture your Unix session and connect to Sqlplus with:

```
>script   username_assn2que2
>sqlplus <username>
>password
SQL> CREATE TABLE Customer
(SSN              NUMBER(6) NOT NULL,
 CName            VARCHAR2(15),
 Caddress         VARCHAR2(35),
 balance          NUMBER(5, 2),
 PRIMARY          KEY(SSN));

SQL> CREATE TABLE PhoneCompany
(CompId           NUMBER(4) NOT NULL,
 Cname            VARCHAR2(15),
 Caddress         VARCHAR2(35),
 Numproducts      NUMBER(3),
 PRIMARY          KEY(Compid));

SQL> CREATE TABLE Subscribesto
(SSN              NUMBER(6) NOT NULL,
CompId            NUMBER(4) NOT NULL,
phonetype         VARCHAR2(15),
month             VARCHAR2(15),
billamt           NUMBER(6,2),
PRIMARY KEY(SSN, CompId),
FOREIGN KEY (SSN) REFERENCES Customer(SSN),
FOREIGN KEY (CompId) REFERENCES PhoneCompany(CompId));

SQL> INSERT INTO Customer
VALUES (10111, 'John Smith', '2 Sunset Avenue, Windsor', 56.60);
SQL> COMMIT;
// Repeat similar INSERT instructions for all the data in your tables
// starting with the entity tables first, eg, Customer, PhoneCompany,
// before Subscribeto.

SQL> select * from cat;   // to show all the constructs in your catalogue
SQL> select * from Customer;  // to show the contents of this table
// Also use similar select * from PhoneCompany and from Subscribeto

SQL> exit                 //to exit sqlplus

exit                      // to exit and create script file that has a log of your unix session
```

Solution: (10 marks)

An attached script showing execution of CREATE TABLE instructions and INSERT INTO table instructions with the few SELECT instructions to show contents of the catalogue and your three tables.

CHAPTER 14: Database Design Theory: Introduction to Normalization Using Functional and Multivalued Dependencies

3. (total marks 10) Consider the following relation:

Enrolled (Studid, Crsid, Ctitle, Score, Lettergrade)

Assume that a student (Studid) may be enrolled in multiple courses (Crsid) and hence {Studid, Crsid} is the primary key.
Thus, the following functional dependency exists:

{Studid, Crsid } -> {Ctitle, Score, Lettergrade}

Additional dependencies are:

Crsid -> Ctitle

Score -> Lettergrade

Based on the given primary key,

i. Is this relation in 1NF, 2NF, or 3NF? Why or why not?
ii. If not in 2NF at least, normalize it completely into 2NF and 3NF? Provide your answers using functional dependencies (FDs).

(Total for que 3 is 10 marks)

Solution (i): (5 marks)

Answer:
Given the relation schema
Enrolled(Studid, Crsid, Ctitle, Score, Lettergrade)

{Studid, Crsid } -> {Ctitle, Score, Lettergrade}
Crsid -> Ctitle
Score -> Lettergrade

This relation Enrolled satisfies 1NF but not 2NF because there is part of the primary key that determines a non-key attribute (Crsid -> Ctitle).
So the attribute (Crsid) is not FFD on the primary key {Studid, Crsid } and the relation is not in 3NF because it is not in 2NF and there is transitive dependency between the primary key and some non-key attributes, e.g., Lettergrade (eg., {Studid, Crsid } -> Score;
and Score -> Lettergrade) since Lettergrade is transitively dependent on the primary key through the non key attribute score.

Solution (ii) (5 marks)

To normalize into 2NF and 3NF, we break the relations into relations that have only FDs that are FFD on the primary key for 2NF and also relations that have only FDs in each relation that are not transitively dependent on the primary key. The results are given below.

2NF: (keep only relations with FDs that are FFD on PK)
Enrolled1(Studid, Crsid, Score, Lettergrade)
Enrolled2(Crsid, Ctitle)

3NF: (Also remove the transitive dependencies)
Enrolled1(Studid, Crsid, Score)
Enrolled2(Crsid, Ctitle)
Enrolled3(Score, Lettergrade)

4. (total marks 10) What (i) update, (ii) delete and (iii) insertion anomalies occur in the DEPARTMENT_PROJECT relation obtained by doing a cross product (used for natural joins but excluding project.Dnum) of the two relations DEPARTMENT and PROJECT of Fig 14.2 on page 463 of book? Explain with examples using this database, the DEPARTMENT_PROJECT relation schema and the functional dependencies with a state given below as Figures 4.1 and 4.2. (Total for que 4 is 10 marks)

Note: 3 marks for correct discussion of each anomaly and 1 marks for attempt.

Figure 14.2 (book): Sample database state for a simplified COMPANY relation DB

EMPLOYEE

Ename	Ssn	Bdate	Address	Dnumber
Smith, John B.	123456789	1965-01-09	731 Fondren, Houston, TX	5
Wong, Franklin T.	333445555	1955-12-08	638 Voss, Houston, TX	5
Zelaya, Alicia J.	999887777	1968-07-19	3321 Castle, Spring, TX	4
Wallace, Jennifer S.	987654321	1941-06-20	291Berry, Bellaire, TX	4
Narayan, Ramesh K.	666884444	1962-09-15	975 Fire Oak, Humble, TX	5
English, Joyce A.	453453453	1972-07-31	5631 Rice, Houston, TX	5
Jabbar, Ahmad V.	987987987	1969-03-29	980 Dallas, Houston, TX	4
Borg, James E.	888665555	1937-11-10	450 Stone, Houston, TX	1

DEPARTMENT

Dname	Dnumber	Dmgr_ssn
Research	5	333445555
Administration	4	987654321
Headquarters	1	888665555

DEPT_LOCATIONS

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

WORKS_ON

Ssn	Pnumber	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	Null

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

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Fig 4.1: DEPARTMENT_PROJECT DB schema suffering from update anomalies

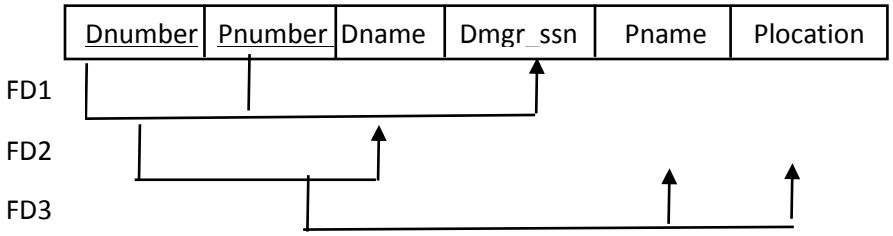

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Fig 4.2: A database state of the DEPARTMENT_PROJECT DATABASE derived from Fig 14.2

DNUMBER	PNUMBER	DNAME	DMGR_SSN	PNAME	PLOCATION
5	3	Research	333445555	ProductZ	Houston
5	10	Research	333445555	Computerize	Stafford
5	20	Research	333445555	Reorganize	Houston
5	30	Research	333445555	Nbenefits	Stafford
5	1	Research	333445555	ProductX	Bellair
5	2	Research	333445555	ProductY	Sugarland
4	3	Administration	987654321	ProductZ	Houston
4	10	Administration	987654321	Computerize	Stafford
4	20	Administration	987654321	Reorganize	Houston
4	30	Administration	987654321	Nbenefits	Stafford
4	1	Administration	987654321	ProductX	Bellair
4	2	Administration	987654321	ProductY	Sugarland
1	3	Headquarters	888665555	ProductZ	Houston
1	10	Headquarters	888665555	Computerize	Stafford
1	20	Headquarters	888665555	Reorganize	Houston
1	30	Headquarters	888665555	Nbenefits	Stafford
1	1	Headquarters	888665555	ProductX	Bellair
1	2	Headquarters	888665555	ProductY	Sugarland

18 rows selected.

Solution: (3 + 3 + 3 + 1 marks)

The primary key is (DNUMBER, PNUMBER) and all non-key attributes should depend on these attributes only and not on part of them or transitively.

i. Update Anomalies: In DEPARTMENT_PROJECT, the partial dependencies {DNUMBER}->{DNAME} and {PNUMBER}->{PNAME,PLOCATION} can cause update anomalies. For example, all PROJECT records whose Pnumber is 2 (about 3 records) all have {PNAME, PLOCATION} as {ProductY, Sugarland}. We cannot update any of these records to something else or the database integrity is violated. If we are able to update some of the records to something else, the database is violated as the FD will no longer hold. We must remember these multiple column associations that indicate data redundancy and change them all in all the associated row records or there is a violation and this is update anomaly.

ii. Delete Anomalies: : For example, if a PROJECT temporarily has no DEPARTMENTS working on it, its information (PNAME, PNUMBER, PLOCATION) will not be represented in the database when the last DEPARTMENT working on it is removed (this is deletion anomaly).

iii. Insertion anomaly: Inserting a new tuple relating an existing DEPARTMENT to an existing PROJECT requires checking both partial dependencies; for example, if a different value is entered for PLOCATION than those values in other tuples with the same value for PNUMBER, we get an update anomaly. Also, if a project is not yet assigned to a department, its record cannot be inserted into the database and this is insert anomaly.