King Saud University

College of Computer and Information Sciences

Department of Information Systems

Introduction to Database Systems (IS230)

First Semester 1437/1438 (Fall 2016)

Final Exam - Date: 9/1/2017

Exam Duration : 3 hours

Total Points : 400 Points – Answer Model

Student Name: First, Middle, Last

Student ID Number:

Question Number	MCQ/50	Q2/50	Q3/60	Q4/60	Q5/60	Q6/60	Q7/60	Total /400
Student /Course Outcome	G 1,2	B 2	B,C 2,3	C 2,3	I 2,3	C 2,3	J 1,2,3	
Marks								

#	Course Outcomes	Student Outcomes									
		A	B	C	D	E	F	G	H	I	J
1	Understand the basics and concepts of database systems							x			x
2	Design, implement and evaluate a computer-based DB system to meet desired users' needs		x	x				x		x	x
3	Use professionally Structured Query Language (SQL) and understand SQL processing			x						x	x

Student Outcome	Outcome Description
B	An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
C	An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
G	An ability to analyze the local and global impact of computing on individuals, organizations, and society
I	An ability to use current techniques, skills, and tools necessary for computing practice
J	An understanding of processes that support the delivery and management of information systems within a specific application environment

Q1) (50 Points) Answer Only 10 True and False (T/F) Question

Q1) The database administrator coordinates all the activities of the database system.	
a) True	b) False

Q2) In the database approach programs are mixed with data.	
a) True	b) False

Q3) A view contains virtual data derived from the database files but is not explicitly stored .	
a) True	b) False

Q4) When transforming a weak entity, one should create one relation with both the attributes of the strong entity and the attributes of the weak entity.	
a) True	b) False

Q5) A candidate key of an entity set is a minimal primary key.	
a) True	b) False

Q6) A weak entity set do not have a primary key.	
a) True	b) False

Q7) The asterisk (*) wildcard designator can be used to select all fields from a table, as well as in WHERE clauses when an exact match is not possible.	
a) True	b) False

Q8) When a GROUP BY clause is included in an SQL statement, only those columns with a single value for each group can be included.	
a) True	b) False

Q9) $\prod_{a,b} \sigma_{a>10}(r)$ is equivalent to SELECT DISTINCT a, b FROM r HAVING a>10; .	
a) True	b) False

Q10) A functional dependency represents the quality of the relationship between two tables	
a) True	b) False

Q11) Third Normal Form (3NF) eliminates transitive dependencies - i.e. those dependencies which hold only because of some intermediary.	
a) True	b) False

Q2) (50 Points) Given the following "Company" Database, determine if any constraints will be violated by each of the following operations. If there is a violation then write the type of integrity constraint violation and explain it briefly with the action that will be taken.

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

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

WORKS_ON

Essn	Pno	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

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

(5 Points) Insert <‘Cecilia’, ‘F’, ‘Kolonsky’, NULL, ‘1960-04-05’, ‘6357 Windy Lane, Katy, TX’, F, 28000, NULL, 4> into EMPLOYEE.

Accepted (Yes / No)? No

if (No), why? It violates the entity integrity constraint (NULL for the primary key SSN)

(5 Points) Insert <‘Alicia’, ‘J’, ‘Zelaya’, ‘999887777’, ‘1960-04-05’, ‘6357 Windy Lane, Katy,

TX’, F, 28000, ‘987654321’, 4> into EMPLOYEE.

Accepted (Yes / No)? No

if (No), why? It violates the key constraint because another tuple with the same SSN value already exists in the EMPLOYEE relation

(5 Points) Insert <‘Cecilia’, ‘F’, ‘Kolonsky’, ‘677678989’, ‘1960-04-05’, ‘6357 Windswept,

Katy, TX’, F, 28000, ‘987654321’, 7> into EMPLOYEE.

Accepted (Yes / No)? No

if (No), why? It violates the referential integrity constraint specified on Dno in EMPLOYEE because no corresponding references tuple exists in Department with Dnumber = 7

(5 Points) Delete the WORKS_ON tuple with Essn = ‘999887777’ and Pno = 10.

Accepted (Yes / No)? Yes

if (No), why?

(5 Points) Delete the EMPLOYEE tuple with Ssn = ‘453453453’.

Accepted (Yes / No)? No

if (No), why? It violates referential integrity constraint because there are tuples in WORKS_ON that refer to this tuple

(5 Points) Delete the EMPLOYEE tuple with Ssn = ‘333445555’.

Accepted (Yes / No)? No

if (No), why? It violates referential integrity constraint because there are tuples in EMPLOYEE, DEPARTMENT, WORKS_ON, and DPENDENT that refer to this tuple

(5 Points) Update the Dno of the EMPLOYEE tuple with Ssn = ‘999887777’ to 1.

Accepted (Yes / No)? Yes

if (No), why?

(5 Points) Update the Ssn of the EMPLOYEE tuple with Ssn = ‘999887777’ to ‘987654321’.

Accepted (Yes / No)? No

if (No), why? It violates primary key constraint by repeating a value that already exists as a primary key in another tuple. It also violates referential integrity constraint because there are other relations that refer to the existing value of SSN

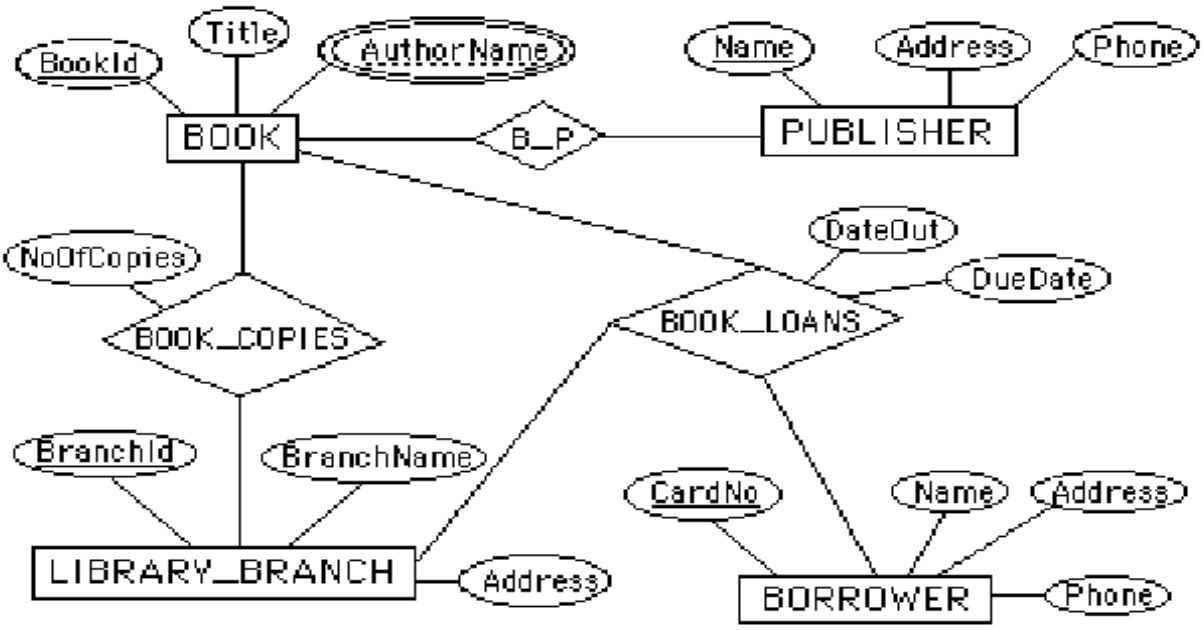
(5 Points) Update the Dno of the EMPLOYEE tuple with Ssn = ‘888665555’ to 4.

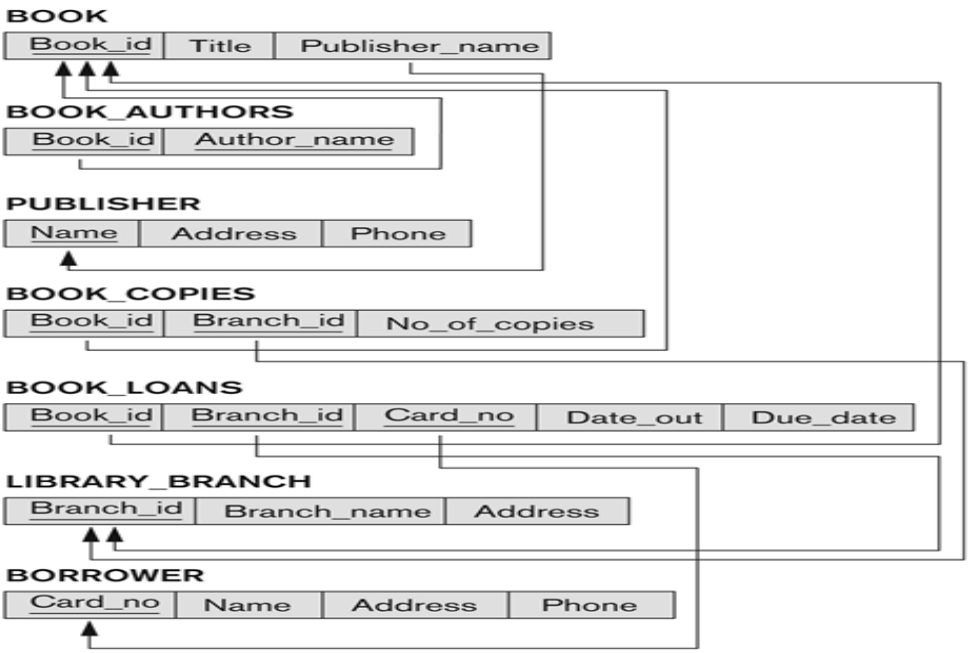
Accepted (Yes / No)? Yes
if (No), why?

(5 Points) Update the salary of the EMPLOYEE tuple with Ssn = ‘987987987’ to 28000.

Accepted (Yes / No)? Yes
if (No), why?

Q3) (60 Points) The following figure shows an ER Diagram for a database that used to keep track of Books loans. Map this ER Diagram into a relational schema, and specify all primary keys and foreign keys.

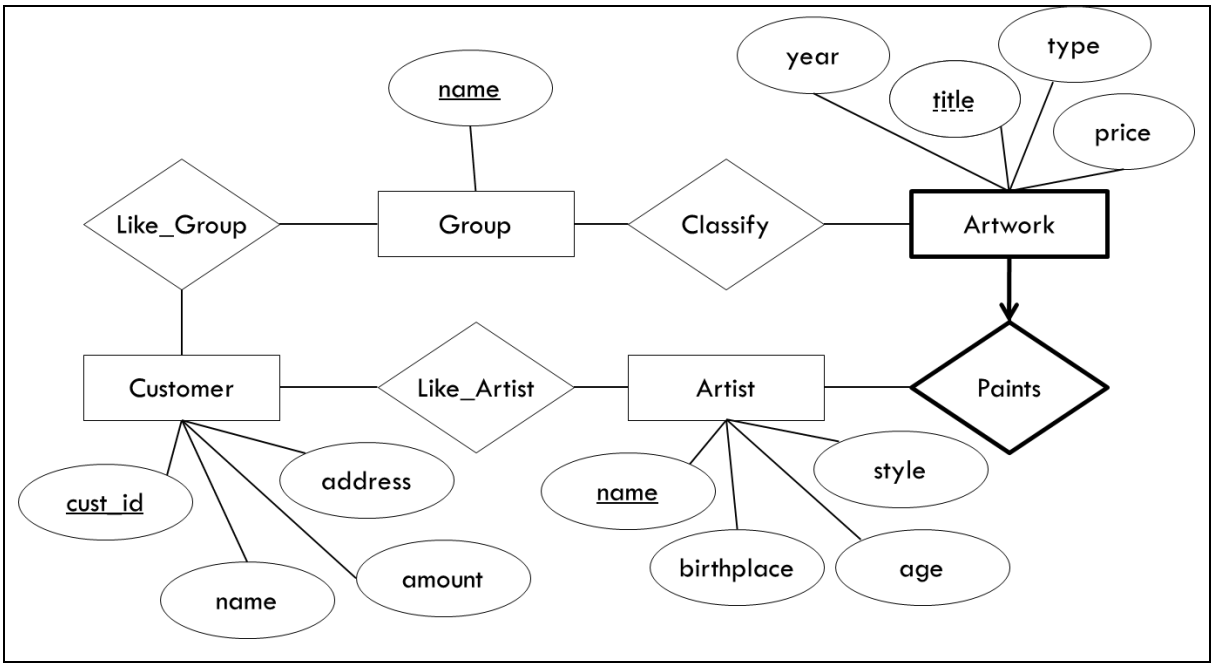




Q4) (60 Points) A company specialized in art galleries needs to maintain information about galleries. The following are the requirements:

1. Galleries keep information about artists, their names (which are unique), birthplaces, age, and style of art.
2. For each piece of artwork, the artist, the year it was made, its unique title, its type of art (e.g., painting, lithograph, sculpture, photograph), and its price must be stored. Assume that each piece of artwork is painted by exactly one artist.
3. Pieces of artwork are also classified into groups of various kinds, for example, portraits, still lifes, works by Picasso, or works of the 19th century; a given piece may belong to more than one group. Each group is identified by a name (like those just given) that describes the group. Pieces of artwork of different artists may have the same title, but each one should be identified with its artist.
4. Finally, galleries keep information about customers. For each customer, galleries keep that person's unique name, address, total amount of dollars spent in the gallery, and the artists and groups of art that the customer tends to like.

Draw an E-R diagram for the customer database. Specify in the diagram the primary keys, the cardinality and participation constraints.



Q5) (60 Points) The following Database state introduces an example, concerning World War 2 capital ships. It involves the following relations:

- ShipModels(**model**, type, country, numGuns, bore, displacement)
- Ships(**shipName**, model, launched)
- Battles(**battleName**, date)
- Outcomes(**shipName**, **battleName**, result)

The relation ShipModels records the name of the model, the type('bb' for battleship or 'bc' for battlecruiser), the country that build the ship, the number of main guns, and their size (bore), and the displacement(weight, in tons). Relation Ships records the name of the ship, the model of the ship, and the year in which the ship was launched. Relation Battles gives the name and date of battles involving these ships, and relation Outcomes gives the result (sunk, damaged, ok) for each in each battle. The following shows sample instances for these relations.

Sample data for ShipModels

model	type	country	numGuns	bore	displacement
Bismarch	bb	Germany	8	15	42000
Iowa	bb	USA	9	16	46000
Kongo	bc	Japan	8	14	32000
North Carolina	bb	USA	9	16	37000
Renown	bc	Britain	6	15	32000
Revenge	bb	Britain	8	15	29000
Tennessee	bb	USA	12	14	32000
Yamoto	bb	Japan	9	18	65000

Sample data for Ships

shipName	model	launched
California	Tennessee	1921
Haruna	Kongo	1915
Hiei	Kongo	1914
Iowa	Iowa	1943
Kirishma	Kongo	1915
Kongo	Kongo	1913
Missouri	Iowa	1944
Musashi	Yamoto	1942
New Jersey	Iowa	1943
North Carolina	North Carolina	1941
Ramillies	Revenge	1917
Renown	Renown	1916
Repulse	Renown	1916
Resolution	Revenge	1916
Revenge	Revenge	1916
Royal Oak	Revenge	1916
Royal Sovereign	Revenge	1916
Tennessee	Tennessee	1920
Washington	North Carolina	1941
Wisconsin	Iowa	1944
Yamota	Yamoto	1941

Sample data for Outcomes

shipName	battleName	result
California	Surigao Strait	ok
Kirishma	Guadalcanal	sunk
Tennessee	Surigao Strait	ok
Washington	Guadalcanal	ok
Washington	North Cape	sunk
Royal Oak	North Cape	damaged
Royal Oak	Surigao Strait	sunk

Sample data for Battles

battleName	date
Denmark Strait	5/25/41
Guadalcanal	11/15/42
North Cape	12/26/43
Surigao Strait	10/25/44

Write an SQL statement for the following queries:

1) (7 Points) Write the create table statement of the table *Ships*, specify the primary key, foreign keys and any constraint.

CREATE TABLE Ships (

```
shipName        Char(30)   NOT NULL,
model           Char(30),
launched        int,
PRIMARY KEY (shipName),
FOREIGN KEY (model) REFERENCES shipModels (model),
ON DELETE CASCADE          ON UPDATE CASCADE;
```

2) (8 Points) Find the models of ships which participated in battles “Guadalcanal” or “North Cape”. Order the results in alphabetical order.

```
Select model
From Outcomes O, Ships S
Where O.shipName = S.Shipname
AND       battleName = “Guadalcanal” OR battleName = “North Cape”
Order by ShipName;
```

3) (7 Points) Find the name of all ships that begin with the letters “Re”

```
Select shipName
From Ships where shipName like "R%";
```

4) (8 Points) Find the countries whose ships had the largest number of guns.

```
Select country
From ShipModels
Where numGuns =
      (Select max(numGuns)
       From ShipModels);
```

OR

```
Select country
From ShipModels
Where numGuns >= All
       (Select numGuns
        From shipModels)
```

5) (7 Points) Find the models of ships, at least one of which was sunk in a battle

```
Select Model
From Ships
Where shipName in
                  (Select shipName
                   From Outcomes
                   Where result = 'sunk')
```

6) (8 Points) For each ShipModel with at least four ships, find the year in which the first ship of that model was launched.

```
Select model, min(launched)
From Ships
Group by model
Having count(*) > 3
```

7) (7 Points) Delete from table Ships all ships sunk in battles.

```
Delete From Ships
Where shipName in
                (Select shipName
                 From Outcomes
                Where result = 'sunk');
```

8) (8 Points) Create a view “shipModelSunk” including each ShipModel that has participated in a battle, and the number of ships of that model sunk in battles.

```
create view shipModelSunk as
        Select model, count(O.shipName)
        From Outcomes O, Ships S
        Where S.shipName=O.shipName AND O.result = 'sunk'
        Group by model
```

Q6) (60 Points) Consider the following Book Store database schema held in a relational DBMS .

BOOK (BookNumber , Title, Publisher_name, Year)

BOOK_AUTHORS(BookNumber, Author_name, Author_Email)

PUBLISHER(Name, Address, Phone, URL, Email)

BOOK_COPIES(Book_id, Branch_id, No_of_copies)

BOOK_LOANS (Book_id , Branch_id, Card_no , Date_out, Due_date)

BOOKSTORE_BRANCH (Branch_id , Branch_name, Address, URL, Phone)

BORROWER (Card_id, First_Name, Last_Name, Address, Phone, Email)

Write down relational algebra expressions for the following queries on the Book Store database.

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

$X1 \leftarrow \pi_{Card\_no}(BORROWER) - \pi_{Card\_id}(BOOK\_LOANS)$

$RESULT \leftarrow \pi_{Name}(BORROWER * X1)$

(b) For each book that is loaned out from the "Alnassiem" branch and whose Due_Date is '30/11/2016', retrieve the book title, the borrower's name, the borrower's email, and the borrower's address.

$X1 \leftarrow \pi_{Branch\_id}(\sigma_{Branch\_name=' Alnassiem '}(BOOKSTORE\_BRANCH))$

$X2 \leftarrow \pi_{Book\_id,Card\_no}((\sigma_{Due\_date='30/11/2016'}(BOOK\_LOANS)) * X1)$

$RESULT \leftarrow \pi_{Title,Name,,Email,Address}(BOOK * BORROWER * X2)$

(c) For each Book Store branch, retrieve the branch name and the total number of books loaned out from that branch.

$X1(Branch\_id,Total) \leftarrow Branch\_id\ \Im\ COUNT(Book\_id,Card\_no)(BOOK\_LOANS)$

$RESULT \leftarrow \pi_{Branch\_name,Total}(X1 * BOOKSTORE\_BRANCH)$

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

$X1(Card\_no,Total\_check\_out) \leftarrow Card\_no\ \Im\ COUNT(Book\_id)(BOOK\_LOANS)$

$X2 \leftarrow \sigma_{Total\_check\_out > 5}(X1)$

RESULT ← $\pi_{Name,Address,Total\_check\_out}$ (X2 * BORROWER)

(e) For each book authored (or co-authored) by "Stephen King", retrieve the title and the number of copies owned by the library branch whose name is "Central".

X1 (Book_id,Title) ← ($\sigma_{Author\_name='Stephen\ King'}$ (BOOK_AUTHORS)) * BOOK

X2 (Branch_id) ← $\sigma_{Branch\_name='Central'}$ (BOOKSTORE _BRANCH)

Q7) (60 Points) Assume relation R has the following functional dependencies:
R = { **O , P** , Q , R , S , T , U , V , W , X , Y , Z, N} , where { Z } is a multi-valued attribute and T is a composite attribute consists of T1 and T2.

FD1: R → { S , T }

FD2: P → { R , S , T, N}

FD3: U → { V , W , X, Q }

FD4: Y → { P }

Decompose relation R until satisfying the highest normal form. In each step say why the relation is or is not in a normal form and show the result of your decomposition.

1NF

R11 = { **O , P** , Q , R , S , T 1,T2, U , V , W , X , Y, N } R12= {**O , P** , Z}

2NF

R21 = { **O , P** , Q , U , V , W , X, Y } R22 = { **P**, R , S , T1,T2, N } R12= {**O , P** , Z}

3NF

R31 = { **O , P** , U , Y } R32 = { **U,** V , W , X, Q } R33 = { **P**, R, N } R34 = { R, , S , T1,T2 } R12= {**O , P** , Z}

BCNF

R41 = { A , U , Y } R42 = { P , Y }

R32 = { U, V , W , X, Q } R33 = { P, R, N } R34 = { R, , S , T1,T2 }

R12= {**O , P** , Z}