2023 EXAMINATIONS

Lancaster University

Part II

COMPUTING AND COMMUNICATIONS Written Exam [2.5 hours]

SCC.201 DATABASES

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*Candidates are asked to answer **THREE** questions from **FOUR**; each question is worth 25 marks.*

Use a separate answer book for each question.

Question 1

Entity relationship diagrams

1.a. Please draw the ER diagram for the given description.

InfoLab21 corp plans to introduce a new chapter for the Zork Nemesis series. As in the case of *Zork Nemesis 2: The revenge of the fallen*, in the new game *Zork Nemesis 3: Uraz's game,* a player has a unique *playerID*, with a *Name*, and an *email_address*. A player must have at least one character, and a character may have at most one associated player. A character has a unique *characterName*, with *Power*, *Rating*, *Money*, and *ExperienceScore*. A character may own several inventory items. An inventory item has a unique *Item_type*, with a *Price*, and a *Wearable* attribute. An inventory item belongs to one character; the inventory information must be removed from the database when a character is deleted.

[5 marks]

1.b. Please provide the Relational Schema and Integrity Constraints for the relations derived from your ER diagram.

[5 marks]

1.c. Select True or False.

i. ***True / False*** A relational database requires integrity constraints to create relations between different entity sets.

[1 mark]

ii. ***True / False*** Relational algebra allows designers to set participation constraints.

[1 mark]

iii. ***True / False*** A superkey contains the set of all possible keys for a given relation.

[1 mark]

iv. ***True / False*** A Foreign Key references another relation's primary key.

[1 mark]

v. ***True / False*** If all foreign keys are set, we achieve domain constraint.

[1 mark]

vi. ***True / False*** Prime attribute is an attribute that has no functional dependencies.

[1 mark]

vii. ***True / False*** A relation having multivalued attributes is in 1st Normal Form

[1 mark]

viii. ***True / False*** DML stands for data management language

[1 mark]

Question 1 continues on the next page…

Question 1 continued.

1.d. Provide the names of given ER symbols.

A)  **[0.5 mark]**

B)  **[0.5 mark]**

C)  **[0.5 mark]**

D)  **[0.5 mark]**

E)  **[0.5 mark]**

F)  **[0.5 mark]**

G) 

[0.5 mark]

H) 

[0.5 mark]

I) 

[0.5 mark]

J) 

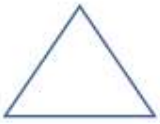
[0.5 mark]

K) 

[0.5 mark]

L) **[0.5 mark]**

M) **[0.5 mark]**

N)  **[0.5 mark]**

[Total 25 Marks]

Question 2

Functional Dependencies and Normal forms

2.a. Let ***R(A,B,C,D)*** be a relation with functional dependencies ***{A->C, C->D}***. By using the Armstrong's Axioms prove that {***AB->ABCD***}. Show all the steps involved.

[5 marks]

2.b. What is the normalisation level of relation *R*?

[2 marks]

2.c. By decomposing the relation R, create relations in the Boyce-Codd normal form and show that they are indeed in the Boyce-Codd normal form.

[7 marks]

2.d. Fill in the blanks

I. A …… between attributes X, Y (X -> Y) holds over relation R if, for every allowable instance *r* of R given two tuples in *r*, if the X values agree, then the Y values must also agree.

[2 marks]

II. If a table is……., and decomposed into smaller tables, it is known that certain kinds of problems are avoided/minimised.

[2 marks]

III. ……. Normal Form: No set-valued attributes.

[2 marks]

Question 2 continues on the next page…

Question 2 continued.

EMP_ID	PROJECT_ID	MANAGER
1	23	Mr.X
1	67	Mr.Z
2	45	Mr.X
3	78	Mr.Y
3	23	Mr.X
4	23	Mr.X
5	78	Mr.Y
5	67	Mr.Z

2.e. The above given instance of relation ***R(EMP_ID,PROJECT_ID, MANAGER)*** has a primary key **{EMP_ID,PROJECT_ID}**. Identify:

I. Give the Functional dependencies of R. **[2.5 marks]**

II. Print the non-prime attributes of R. **[2.5 marks]**

Question 2 TOTAL 25pts.

```
SELECT charName
FROM Character
JOIN Players ON Players.AccountNo = Characters.AccountNo
WHERE playerId = 'xxx'
```

Question 3

SQL and relational algebra

Consider the tables:

Players (playerId, AccountNo, email)

Characters (AccountNo, CharName, Power, Rating, Money, ExperienceScore, Item_type)

Inventory (Item_type, Price, Wearable)

3.a. Write the SQL statements for the given queries:

I. Find the ID of a player who uses all items. **[3 marks]**

```
SELECT p.playerId
FROM Players p
JOIN Characters c ON p.AccountNo = c.AccountNo
GROUP BY p.playerId
HAVING COUNT(DISTINCT c.Item_type) = (SELECT COUNT(DISTINCT
Item_type) FROM Inventory);
```

II. Find the Account number of a player having playerId>20 for each rating with at least 5 characters. **[5 marks]**

```
SELECT p.AccountNo, c.Rating
FROM Players p
JOIN Characters c ON p.AccountNo = c.AccountNo
WHERE p.playerId > 20
GROUP BY p.AccountNo, c.Rating
HAVING COUNT(*) >= 5;
```

III. Find the emails for the player whose id begins with "007". **[3 marks]**

```
SELECT email
FROM Players
WHERE playerId LIKE '%007%';
```

IV. Find the email for the player whose id is "007". **[4 marks]**

```
SELECT email
FROM Players
WHERE playerId = '007';
```

3.b. Write the Relational Algebra statements for the given queries:

I. Retrieve the email address of the player with AccountNo 18811938.

[5 marks]

II. Retrieve the playerId of the player who uses item type where Wearable=1.

[4 marks]

III. Retrieve the email address of players who use all wearable items.

[1 mark]

Question 3 TOTAL 25pts

Question 4

Database Management Systems

3	0011
6	0110
12	1100
13	1101
4	0100
14	1110

4.a. Starting from empty buckets where each bucket can have two items, **insert given values following their order** {3, 6, 12, 13, 4, 14} to a hash using Extendible Hashing where the global depth is one (i.e., `d=1`). Please work with the binary representations (given). **Please draw the final directory for the Extendible Hashing Algorithm.**

[5 marks]

4.b. Explain and discuss three query optimisation techniques, and state the use of internal and leaf nodes of a canonical query tree.

[5 marks]

Question 4 continues on the next page…

4.c. Explain three properties of internal nodes of B+ trees.

[6 marks]

4.d. Consider the different states a database transaction can be in and the possible transitions between them and answer the following questions.

I. Please draw a diagram showing the different states and transitions between these states.

[4 marks]

Question 4 continues on the next page…

Question 4 continued.

II. Explain these states.

[5 marks]

Q4 TOTAL 25pts