

2023 EXAMINATIONS



**Part II**

**COMPUTING AND COMMUNICATIONS Written Exam [2.5 hours]**

**SCC.201 DATABASES**

---

*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 1<sup>st</sup> 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  $\{A \rightarrow C, C \rightarrow D\}$ . By using the Armstrong's Axioms prove that  $\{AB \rightarrow ABCD\}$ . 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  $X, Y$  ( $X \rightarrow Y$ ) 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';
```

**Question 3 continued.**

**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...



**Question 4 continued.**

**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**