FUNDAMENTALS OF RDBMS
(CSEN 4281)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) In airline reservation system, the entities are date, flight number, place of departure, destination, type of plane and seats available. The primary key is
(a) flight number (b) flight number + place of departure
(c) flight number + date (d) flight number + destination.

(ii) The concept of locking can be used to solve the problem of
(a) lost update (b) uncommitted dependency
(c) inconsistent data (d) deadlock.

(iii) Consider **R1** and **R2** are two different relations, which operation will produce a relation that has all attributes of **R1** and **R2** and guaranteed to have tuples
(a) Union (b) Intersection
(c) Cartesian Product (d) Join.

(iv) An attribute of one table matching the primary key of another table, is called as
(a) foreign key (b) secondary key
(c) candidate key (d) composite key.

(v) If every non-key attribute is functionally dependent on the primary key, then the relation will be in
(a) first normal form (b) second normal form
(c) third normal form (d) fourth normal form.

(vi) For a relation **R = { J, K, L }** with functional dependencies **F = { JK –>L ; L –> K }** the candidate keys are:
(a) Both J and K (b) JK
(c) only J (d) JK and JL

(vii) Student and courses enrolled, is an example of
(a) one-to-one relationship (b) one-to-many relationship

(c) many-to-one relationship (d) many-to-many relationship.

(viii) Given the functional dependencies
X - > W; X-> Y; Y->Z and Z-> R
Which of the following does not hold good?
(a) X->Z (b)W->Z (c) X-> WY (d) none.

(ix) If a relation schema is in BCNF, then it is also in
(a) first normal form (b) second normal form
(c) third normal form (d) all of the above.

(x) Assume transaction X holds a shared lock R. If transaction B also requests for a shared lock on R
(a) it will result in a deadlock situation
(b) it will immediately be granted
(c) it will immediately be rejected
(d) it will be granted as soon as it is released by X.

Group – B

2. (a) (i) Distinguish between *Super Key* and *Candidate key.*
(ii) Illustrate the functions of the various layers of the ANSI-SPARC architecture for database systems.

(b). (i) Distinguish between *procedural* DML[Data Manipulation Language] and *non-procedural* DML .
(ii) How does physical data independence differ from logical data independence?

(2 + 4) + (3 + 3) = 12

3. (a) (i) Distinguish between *instance* and *schema*. Explain with suitable examples.
(ii) Illustrate the role of data dictionary and meta data in the context of Data Definition Languages.

(b) Draw an ER Diagram to model a very simple online book store. Keep in mind the minimum constraints and attributes given below.

- A **Book** can be identified by its *ISBN*. The book has a *title*, *year of publishing*, and *price* recorded against it.
- A **Book** is written by one or more **Authors**. Each author can be identified uniquely by his/her *Name* and *Address*. An author may/may not have a *website*. An author may/may not have *multiple books* to his/her credit. An author may be *related with any number of publishers*.
- A book is published by a **Publisher** who can be uniquely identified by their name. A publisher has some *address* and *phone number*. A publisher may publish any *number of books*. A publisher *pays* the author rights and royalties as commission for a book. A publisher may be associated with *any number of authors*.
- A **Customer** registers via his/her email id and information about their *name*, *address*, and *phone number* is recorded. The customer may *add several*

(different books / same book, multiple copies) books to their shopping **Cart**. The customer should be shown the *total price* during checkout.

You may assume additional conditions in your representations. Make sure to clearly state such assumptions. (You may wish to look at the questions in the next section to aid in your design).

(3 + 3) + 6 = 12

Group – C

4. (a) (i) Distinguish between total and partial participation with suitable examples.
(ii) Describe the *set difference* and *intersection* operations with respect to Relational Algebra.
(iii) How does the tuple relational calculus differ from the domain relational calculus?

(b) Keeping in mind your design from question **3.b**, write **Relational Algebra Operations** for the following:
(i) Find *name* of all customers who have bought the book ***Harry Potter and the Philosopher's Stone*** published by ***Bloomsbury***.
(ii) Find the *total royalties* received by the author for the ***Harry Potter and the Philosopher's Stone*** from the different publishers.

Find the *name* of the *Highest Priced* book published in ***2019***.

(2 + 2 + 2) + 6 = 12

5. (a) (i) Consider the following relations containing airline flight information:
Flights(*flno*:integer, *from:* string, *to:*string, *distance:* integer, *departs:* time, *arrives:*time)
Aircraft(*aid:* integer, *aname:* string, *cruisingrange:* integer)
Certified(*eid:*integer, *aid:* integer)
Employees(*eid:* integer, *ename:* string, *salary:* integer)
Note that the Employees relation describes pilots and other kinds of employees as well; every pilot is certified for some aircraft (otherwise, he or she would not qualify as a pilot), and only pilots are certified to fly.

Write any two of the following queries in relational algebra:
- Find the names of pilots certified for some Boeing aircraft.
- Identify the flights that can be piloted by every pilot whose salary is more than $100,000.
- Find the names of pilots who can operate planes with a range greater than 3,000 miles but are not certified on any Boeing aircraft

(ii) What is meant by Cardinality Ratio? Give suitable examples of *one-one* and *one- many* relationships.

(b) Construct an E-R diagram for an **University Registrar's office**. The office maintains data about each class, including the instructor, the enrollment, and the time and place of the class meetings. For each student-class pair, a grade is recorded. Detail's about every employee involved in the process is also maintained. Document all assumptions that you make about the mapping constraints.

(4 + 3) + 5 = 12

Group – D

6. (a) When is the decomposition of a relation schema R into two relation schemas X and Y said to be a lossless-join decomposition? Why is this property so important? Give a necessary and sufficient condition to test whether a decomposition is lossless-join.

   (b) Consider the **Relational Schema *R*** and set of **Functional Dependencies *F*** given below:
   R(A, B, C, D, E) F={A->BC, CD->E, B->D, E->A}
   Find the Candidate Key(s) of **R** and justify your decision.
   Identify the existing **Normal Form** of **R**, and then decompose it to **BCNF** clearly showing each step and explaining how you achieve the next higher normal form.
   (2 + 2 + 2) + 6 = 12

7. (a) (i) Distinguish between partial dependency and transitive dependency.
   (ii) Define *multi-valued dependencies* and discuss the use of such dependencies for database design.

   (b) Suppose that we decompose the schema R=(A,B,C,D,X) into
   (A,B,C)
   (A,D,X)
   Show that this decomposition is a lossless-join decomposition if the following set F of functional dependencies holds:
   A -> BC
   CD -> X
   B -> D
   X -> A
   (3 + 3) + 6 = 12

Group – E

8. (a) (i) Explain the fundamental concepts of two-phase locking (2PL).
   (ii) Draw and explain the State-Transition diagram of a transaction, also explain the properties of *consistency* and *isolation* with regards to transactions.

   (b) (i) What do you mean by concurrency control?
   (ii) Let ***r1(A)*** mean transaction ***T1*** reads data **A**, ***w1(A)*** mean transaction **T*1*** writes data **A**. Using **precedence graphs**, determine if the schedule **S** is **Conflict Serializable** or not. If it is serializable, write down the **Equivalent Serial Schedule(s)**.
   S: r1 (X); r2 (Z); r1 (Z); r3 (X); r3 (Y); w1 (X); w3 (Y); r2 (Y); w2 (Z); w2 (Y);
   (2 + 4) + (1 + 5) = 12

9. (a) What is view serializability? Suppose a transaction T_1 withdraws Rs.100 from an account with bal_x, initially Rs.1000 and another transaction T_2 deposits Rs.200 into same account. Illustrate the Lost Update problem with this example.

(b) Write short notes on any two of the following:
(i) Inconsistent Analysis Problem
(ii) B+ trees
(iii) Multi-level indexes.

(1 + 5) + (3 + 3) = 12

Department & Section	Submission Link
AEIE, ECE	https://classroom.google.com/w/Mjk3MjQ1MDcwMTk2/tc/MzYxMjg5MzQ0NjY2