DATABASE MANAGEMENT SYSTEMS
(CSEN 3101)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) The subset of a super key is a candidate key under what condition?
(a) No proper subset is a super key (b) All subsets are super keys
(c) Subset is a super key (d) Each subset is a super key.

(ii) The decoupling of external level and the conceptual level of a database architecture is called
(a) logical data independence (b) local data independence
(c) physical data independence (d) non-local data independence.

(iii) Emp(empcode, name, street, city, state, pincode).
In Emp relation, employees have unique empcode and all the attributes are atomic. For any pincode, there is only one city and state. Also, for given street, city and state, there is just one pincode. In normalization terms, Emp is a relation in
(a) 1 NF only (b) 2 NF and hence also in 1 NF
(c) 3 NF and hence also in 2 NF and 1 NF (d) BCNF and hence also in 3 NF, 2 NF and 1 NF.

(iv) '_ _ _ %' matches any string of _____ three characters.
(a) atleast (b) exactly (c) atmost (d) all

(v) Ensuring isolation property is the responsibility of the
(a) recovery-management component of the DBMS
(b) transaction-management component of the DBMS
(c) concurrency-control component of the DBMS
(d) buffer management component in DBMS.

(vi) CREATE TABLE employee (id INTEGER,name VARCHAR(20),salary NOT NULL);
INSERT INTO employee VALUES (1005,Rach,0);
INSERT INTO employee VALUES (1007,Ross,);
INSERT INTO employee VALUES (1002,Joey,335);
Some of these insert statements may produce an error. Identify the statement.
(a) Insert into employee values (1005,Rach,0);
(b) Insert into employee values (1002,Joey,335);
(c) Insert into employee values (1007,Ross,);
(d) No error.

(vii) If you were collecting and storing information about your music collection, albums would be considered a/an _____
(a) Relation (b) Entity (c) Instance (d) Attribute.

(viii) The property of a transaction that persists all the system crashes is
(a) Persistency (b) Atomicity (c) Consistency (d) Durability.

(ix) Index which has an entry for some of key value is classified as
(a) Linear index (b) Dense index (c) Sparse index (d) Cluster index.

(x) In Two-phase locking, a transaction must
(a) ensure that deadlocks will never occur
(b) not obtain any new locks once it has started releasing locks
(c) only obtain locks on items not used by any other transactions
(d) release all it locks at the same time.

Fill in the blanks with the correct word

(xi) The ability to query data, as well as insert, delete, and alter tuples, is offered by _____ Language.

(xii) Collection of information stored in a database at a particular moment is called _____ of the database.

(xiii) In ER diagram, double rectangle is used to denote _____.

(xiv) The _____ expression provides a set of operations that take one or more relations as input and return a relation as an output.

(xv) The "all-or-none" property of a transaction is commonly referred to as _____.

Group - B

2. (a) Name the different levels of data abstraction of the three-tier database architecture. Which level has the lowest level of abstraction and what does it describe? *[(CO1)(Remember/LOCQ)]*

(b) Consider the following requirements for a simple database for the Indian Premier League (IPL):

- The IPL has many teams; each team is identified by its name.
- Each team has a name, a city, a coach, a captain, a set of players and points.
- Each player belongs to only one team.
- Each player may be identified by his player_id.
- Each player has a name, a specialization (such as batsman, bowler, keeper, all-rounder etc.), and a base price.
- Each player also has injury records consisting of type and description.
- A team captain is also a player. One team has only one captain.
- A game is played between two teams (referred to as host team and guest team)
- Each game has a date (eg. 23rd Nov, 2023) and a result (such as CSK beats RCB).

Construct a clean and concise ER diagram, clearly depicting each entity, required attributes and cardinality / structural constraints of the relationships. Depict any weak entities, recursive relationships and role names, if applicable. *[(CO1)(Design/HOCQ)]*

(1 + 1 + 2) + 8 = 12

3. (a) Consider the given relational schema:
Sailors (<u>sid</u>, sname, rating, age)

Reserves (sid, bid, date)
Boats (bid, bname, color)
Write expressions using relational algebra for the following statements:
i) Find names of sailors who have reserved boat with id 707 (bid).
ii) Find names of sailors who have reserved a red boat
iii) Find the boat id and boat names that are reserved for "5-Jan-2024"
iv) Find the names of sailors older than 25 years who have not reserved any boat.
[(CO2)(Apply/IOCQ)]

(b) Define the following with suitable example(s):
(i) Derived attribute (ii) One-to-Many cardinality. *[(CO1)(Understand/LOCQ)]*

(4 × 2) + (2 × 2) = 12

Group - C

4. (a) Suppose that we decompose the schema R = (A, B, C, D, E) into R_1=(A, B, C), R_2= (A, D, E). Show that this decomposition is a lossless decomposition if the following set F of functional dependencies holds:
A → BC
CD → E
B → D
E →A
[(CO4)(Apply/IOCQ)]

(b) Suppose you are given two relations student(Student ID, Name, Department) and grade_points (grade, points) that provides a conversion from letter grades in the takes (Student ID, Course, Credit, grade) to numeric scores. For example, an "A" grade could be specified to correspond to 4 points, an "A*" to 3.7 points, a "B+" to 3.3 points, a B to 3 points, and so on. The grade points earned by a student for a course offering are defined as the number of credits for the course multiplied by the numeric points for the grade that the student received. The GPA will be "0" for a student who has not taken any course. Assume that no takes tuple has the null value for grade. Write each of the following queries in SQL.
(i) Find the total grade points earned by the student with ID 12345, across all courses taken by the student.
(ii) Find the grade point average (GPA) for the above student, that is, the total grade points divided by the total credits for the associated courses.
Do you think the queries will include the GPA of a student who has not taken any course? If not, rewrite the queries. *[(CO3)(Analyze/HOCQ)]*

4 + (4 + 4) = 12

5. (a) Create the following tables using SQL as per the specifications given:
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, color: string)
Catalog(sid: integer, pid: integer, cost: integer)
The Primary key fields are underlined, and the type of each field is listed after the field name. Identify the constraints and add accordingly. *[(CO3)(Remember/LOCQ)]*

(b) Consider a relation R = (U, V, W, X, Y, Z) and the set of FDs = {U →V, U → W, WX → Y, WX → Z, V → Y}. Compute the Closure of UX using Axioms and showing every intermediate steps. *[(CO4)(Apply/IOCQ)]*

(6 + 2) + 4 = 12

Group - D

6. (a) Describe the different anomalies that may exist in a database without normalisation. *[(CO4)(Understand/LOCQ)]*

   (b) Let R = (V, W, X, Y, Z) be a relational schema and let F be the set of FDs such that F = {Z→V, W→Y, XY→Z, V→WX}. Determine whether the following decompositions are lossy or lossless. Explain your answer properly.
   (i) R1 = (V,W,X) and R2 = (V,Y,Z)
   (ii) R1 = (V,W,X) and R2 = (X,Y,Z) *[(CO4)(Analyse/IOCQ)]*

(3 × 2) + (3 × 2) = 12

7. Suppose you are given a relation R with four attributes A, B, C, D and a set of FDs as B → C, D → A. Answer the following:
   (i) Identify the candidate key(s) for R
   (ii) Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF)
   (iii) If R is not in 3NF, decompose it into a set of 3NF relations that preserve the dependencies.
   If instead of the above FDs, ABC → D, D → A are considered, answer the above three questions again. *[(CO2)(Analyse/IOCQ)]*

[(2 + 2 + 2) × 2] = 12

Group - E

8. (a) If you were about to create an index on a relation, what considerations would you have for the choice of primary index? *[(CO6)(Remember/LOCQ)]*

   (b) Explain Multi-level Indexing. Give example. What is the utility of it? *[(CO6)(Remember/LOCQ)]*

   (c) Why do we need query optimization? *[(CO6)(Remember/LOCQ)]*

4 + (3 + 1 + 2) + 2 = 12

9. (a) Explain briefly the Two-Phase Locking protocol. Why is it used? *[(CO5)(Understand/LOCQ)]*

   (b) Define the following terms with example.
   (i) Isolation (ii) Consistency. *[(CO5)(Remember/LOCQ)]*

   (c) Explain Dirty read problem with a suitable example. *[(CO5)(Understand/LOCQ)]*

4 + (2 + 2) + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	47.92	35.42	16.67

Course Outcome (CO):

After the completion of the course students will be able to

CSEN3101.1. Identify the basic concepts and various data model used in database design. Be able to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.

CSEN3101.2. Formulate relational algebra expression for queries and evaluate it using the concept of query processing and optimization.

CSEN3101.3. Create RDBMS schema mapping various business validations and formulate queries based on that schema using SQL to satisfy business requirements.

CSEN3101.4. Apply normalization and various types of dependencies for evaluating a relational database design.

CSEN3101.5. Apply and relate the concept of transaction, concurrency control and recovery in database.

CSEN3101.6. Understand with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*