SPRING END SEMESTER EXAMINATION-2023
4ᵗʰ Semester B.Tech

DATABASE MANAGEMENT SYSTEM
CS 2004 / CS-2004

(For 2022 (L.E), 2021 & Previous Admitted Batches)

Time: 3 Hours   Full Marks: 50

Answer any SIX questions.
Question paper consists of four SECTIONS i.e. A, B, C and D.
Section A is compulsory.
Attempt minimum one question each from Sections B, C, D.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable
and <u>all parts of a question should be answered at one place only</u>.

SECTION-A

1.   Answer the following questions.   [1 × 10]

(a)   Differentiate between Cartesian product and Join operation with suitable example.

(b)   What do you mean by inconsistent database? Discuss with suitable example.

(c)   What is aggregation? How is it represented using ER diagram? Give example to support your answer.

(d)   Given the relations
      Students(Name, Marks, SchoolNo)
      Schools (SchoolNo, SchoolName, Address)

      Which of the following queries cannot be expressed using the basic relational algebra operations (σ, π, $\times$, $\cup$, $-$) ? Justify.

      (A) School Address of every student
      (B) Students whose name is same as their school name
      (C) The sum of all students' marks
      (D) Name of students of a given school

(e) Consider the following table named Student in a relational database. The primary key of this table is **rollNum**.

rollNum	name	gender	marks
1	Naman	M	62
2	Aliya	F	70
3	Aliya	F	80
4	James	M	82
5	Swati	F	65

The SQL query below is executed on this database.

```
1. SELECT *
2. FROM Student
3. WHERE gender = 'M' AND
4.     marks > 65:
```

What is the number of rows returned by the query? Justify

(f) Write the ACID properties of transaction with citing one example of '**I**' property.

(g) Select the TRUE statement(s) from the following with justification:
   i. A relation R is in 3NF if every non-prime attributes of R is completely functionally dependent on every key of R
   ii. Every relation in 3NF is also in BCNF
   iii. No relation can be in both 3NF and BCNF
   iv. Every relation in BCNF is also in 3NF

(h) Given the following relation instance.

X	Y	Z
1	4	2
1	5	3
1	6	3
3	2	2

Which of the following functional dependencies are satisfied by the instance?
   (a) XY -> Z and Z -> Y
   (b) YZ -> X and Y -> Z
   (c) YZ -> X and X -> Z
   (d) XZ -> Y and Y -> X

(i) In a relation scheme R = (A, B, C, D, E, H) on which the following functional dependencies hold: {A–>B, BC–>D, E–>C, D–>A}, the candidate keys of R are _____

    i.   AE, BE
    ii. AE, BE, DE
    iii. AEH, BEH, BCH
    iv. AEH, BEH, DEH

(j) How many minimum internal nodes are required for 1000 leaf nodes of B+ tree with order P:8. (Assume order P: maximum pointer per node.)

SECTION-B

2. (a) Why concurrency control is needed? Explain lost update, dirty read and incorrect summary problem with suitable example.   [4]

   (b) Describe the three-schema architecture. Why do we need mappings between schema levels? Also, differentiate between logical data independence and physical data independence   [4]

3. (a) Consider the relation E = (P, Q, R, S, T, U) having set of Functional Dependencies (FD).   [4]

   $P \rightarrow Q$, $P \rightarrow R$, $QR \rightarrow S$, $Q \rightarrow T$, $QR \rightarrow U$, $PR \rightarrow U$

   Infer the following members of Axioms applying Armstrong's Axioms and Additional inference rule.

   1. $P \rightarrow T$
   2. $PR \rightarrow S$
   3. $QR \rightarrow SU$
   4. $PR \rightarrow SU$

   (b) Given the following schema,   [4]
   employee (person_name, street, city)
   works (person_name, company_name, salary)
   company (company_name, city)

Give the relational algebra and domain relational calculus expression for the following queries.

(i) Find the names of all employees whose salary is greater than 100000.

(ii) Find the names of all employees who is from Mumbai and works in Delhi.

SECTION-C

4. (a) Consider the following relation R(M, Y, P, X, C) and with the following dependencies : [4]

$$F = \{ M{\rightarrow}X, \{M,Y\} \rightarrow P, X{\rightarrow}C\}$$

Consider the decomposition D = { R1 (M, Y, P), R2 (M, MP, C) }. Check weather this decomposition is lossless or lossy in step by step manner.

(b) What is 4NF? Give an example of a relation schema R and a set of dependencies such that R is in BCNF, but not in 4NF. [4]

5. (a) Find the canonical cover of the following FDs on R(VWXYZ) [4]

FD: V$\rightarrow$W, VW$\rightarrow$X, Y$\rightarrow$VWX

(b) Which normal form is considered adequate for normal database design? Consider a relation with set of functional dependencies (FD) as R(ABCDEF). [4]

FD= AB->CDEF, C->A, D->B, C->D, E->F and B-E.

What is the normal form of the relation?

6. (a) Consider the following two transactions : [4]

$$
\begin{aligned}
T1 : \quad & read\,(\,A\,)\,; \\
& read\,(\,B\,)\,; \\
& if\ A = 0,\ then \\
& B := B + 1\,; \\
& write\,(\,B\,)
\end{aligned}
$$

$$T2 : \text{read}(B);$$
$$\text{read}(A);$$
$$\text{if } B = 0, \text{then}$$
$$A := A + 1;$$
$$\text{write}(A)$$

Add lock and unlock instructions to transactions $T1$ and $T2$, so that they observe the two-phase locking protocol. Can the execution of these transactions result in a deadlock?

(b) Consider the following concurrent schedule   [4]

$$S = R_2(X), W_3(X), W_1(Y), R_2(Y), W_2(Z), R_4(X), R_4(Y)$$

A) Check whether the above schedule is conflict serializable or not with required steps using precedence graph.

B) If the above schedule is conflict serializable, then find all possible equivalent serial schedules.

SECTION-D

7. (a) Assume there are different IPL cricket teams, having   [4]
players in each team. In the ER design, we want to show the following:

There are a set of teams, each team has an ID (unique identifier), name, stadium_name, and to which city this team belongs.

Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), player_name, DoB, age (as derived attribute), start year, and shirt number that he uses.

Teams play matches, in each match there is a host team and a guest team. The match takes place in the stadium of the host team.

For each match we need to keep track of the following:

- The date on which the game is played
- The final result of the match
- The players participated in the match.
- For each player, how many runs he scored, whether or not he took any wicket
- During the match, one player may substitute another player. We want to capture this substitution and the time at which it took place.
- Each match has exactly three umpires (umpire can either be a bowler's end umpire, square leg umpire, third umpire). For each umpair we have an ID (unique identifier), name, contact number (as multi-valued attribute) DoB, years of experience.

Design an ER diagram to capture the above requirements. State any assumptions you have that affect your design. Clearly specify the cardinalities and primary keys.

(b) Map the ERD in above question to create the relational model. (Indicate primary keys as well as referential integrity constraint). [4]

8. (a) Create a B+ tree of order 3, with the following data: [4]
   13, 2, 5, 63, 23, 11,74

(b) A relation R(A,B,C,D,E,G) and FD: AB->C, AC-> B, AD->E, B->D, BC->A, E->G and decompose R into R1(A,B,C) R2(A,D,C,E) R3(A,D,G) [4]

   - Find out the candidate keys of relation R.
   - The above decomposition is lossy or lossless? Justify your answer.
   - The above decomposition is dependency preserving or not? Justify your answer.

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