INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
Mid-Spring Semester Examination 2022-23

Date of Examination: _____ Session: (FN/AN) _____ Duration: **2 hours** Full Marks: **30**

Subject No.: **MA40004/MA60308/MA60050** Subject: **FILE ORGANIZATION AND DATABASE SYSTEMS**

Department/Center/School: **Mathematics**

Specific charts, graph paper, log book, etc., required: **NO**

Special Instructions (if any): Answer **ALL Six (6)** Questions

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1. Consider the following set of requirements for the database of a Car Insurance company.

   Customers own one or more cars each. Each customer has a customer ID, name, and address, and each car has a license number and model name. Each car has associated with it zero to any number of recorded accidents. Every accident has a report ID, date, and place. Each insurance policy covers one or more cars and has one or more premium payments associated with it. A policy has policy ID as its attribute. Each premium payment has a transaction ID, an amount, a due date, and the date when the payment was received.

   (I) Identify the entity sets and the corresponding attributes. Specify the key attributes of each entity set and the relationship among these entity sets.
   (II) Draw an ER diagram that captures the above information.
   (III) Write the relational model and draw the network model corresponding to the above ER diagram with proper justification.

   [1+2+2]

2. Consider the relation R (A, B, C, D) with FDs, F = {AB → C, AB → D, C → A, D → B}

   (I) Identify the candidate key(s) for R.
   (II) Identify the best normal form that R satisfies (1NF, 2NF, 3NF, or BCNF). Justify your answer.
   (III) If R is not in BCNF, if possible, decompose it into a set of BCNF relations that preserve the dependencies. Justify your answer.

   [1+2+2]

3. (I) Give an example of a relational schema (R) and set of FDs (F) such that there are at least three distinct lossless-join decompositions of R into BCNF.
   (II) Consider the relation R (A, B, C, D. E) and the instance set {(p, 2, 3, 4, 5), (2, p, 3, 7, 5), (p, 2, 3, 4, 6)} of R. Now based on the values of 'p', state whether the set violates (a) the FD, BC → D and (b) the MVD, BC↠ D.

   [2+1.5+1.5]

(P.T.O.)

4. (I) If the foreign key of a relation R is the primary key of another relation S, will their join be lossless? Justify your answer.
(II) Prove that if a relation R has only one key, it is in BCNF if and only if it is in 3NF.
(IV) For any two non-null relations R and S, express R ÷ S in terms of basic relational algebra operators, where the number of attributes of R is greater than the number of attributes of S, and illustrate the result with one example.

[2+2+2]

5. Consider the following bank database.

SUPPLIER(s_id, s_name, s_address)
BOOK(acc_no, year_of_pub, title)
USER(card_no,u_name, u_address)
SUPPLY(acc_no, s_id, price, date_of_supply)
BORROW(acc_no, card_no, date_of_issue)

Express the following queries in **relational algebra**:

(I) List the name of those users who have not issued any book
(II) Find the name of those suppliers, who have supplied all the books issued to card number "A11".
(III) List the title and price of the most expensive book.

[2+2+2]

6. Consider the following database:
Customer(c_name, street, city)
Account (acc_no, b_name, balance),
Branch(b_name, b_city),
Loan(l_no, b_name, amount),
Borrower(c_name, l_no),
Deposit(c_name, acc_no)

Express the following quires in **tuple relational calculus**:

(I) Find the loan number for each loan of an amount greater or equal to 10000.
(II) Find the names of all customers who have a loan and an account at "KGP" branch.
(III) Find the names of all customers having a loan at the "KGP" branch.

[1+1+1]

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