F.M:70   Time: 3 hrs.

Attempt any FIVE questions.

1. a) What is the difference between physical and logical data independence? Which one is harder to achieve and why?   (4)
   b) What are the main functions of a database administrator?   (4)
   c) Give the answers in context of following relational algebra operations: (6)
      (i) What are the conditions to be fulfilled for two relations to be involved in a UNION operation?
      (ii) Define the DIVISION operation. Discuss it with an example.
      (iii) How are the OUTER JOIN operations different from the INNER JOIN operations?

2. a) Differentiate the terms 'super key' and 'candidate key'.   (2)
   b) Discuss the entity integrity and referential integrity constraints. Why is each considered important?   (4)
   c) Draw an ER Diagram (with suitable assumptions) for a banking system with the following information.

   A bank has many branches and a large number of customers. A customer can open different kinds of accounts with the bank. The bank keeps track of a customer by his SSN, name, address, date_of_birth and phone number. Age is used as a factor to check whether he is a major. There are different types of loans, each identified by a loan number. A customer can take out more than one type of loan and all branches can give loans. Loans have a duration and interest rate. The account holder can enquire about the balance in his account.

   Design a relational schema of the banking database using the ER Diagram. Specify the primary keys and foreign keys for this schema.   (8)

3. a) What is denormalization and why is it required?   (3)
   b) Given a relation schema R = {A, B, C, D, E, H} and having the following Functional Dependencies (FDs):
      F = {{A → BC}, {CD → E}, {E → C}, {D → AEH}, {ABH → BD}, {DH → BC}}.
      Find the candidate key(s) for relation r(R) with FDs F.   (4)
   c) Discuss the purpose of Boyce-Codd Normal Form (BCNF) and discuss how BCNF differs and stronger than 3NF. Illustrate your answer with an example. When will you prefer 3NF over BCNF?   (7)

4. a) How does multilevel indexing improve the efficiency of searching an index file?

b) How does a B-tree differ from a B$^+$-tree? Why a B$^+$-tree is usually preferred as an access structure to a data file?

c) A STUDENT file with Roll# as the key field includes records with the following Roll# values: 8, 5, 1, 10, 7, 3, 2, 12, 4, 9, 6, 11. Suppose that the search field values are inserted in the given order in a B$^+$-tree of order p = 3 and p_{leaf} = 2. Show how the tree will expand and what the final tree will look like. (3+5+6)

5. a) Explain the desirable properties of transactions. (4)

b) Distinguish between conflict and view serializability. (3)

c) Considered the three transactions T_1, T_2 and T_3 and the schedules S_1 and S_2 given below. Draw the serializability (precedence) graphs for both the schedules and state whether each is serializable or not. If a schedule is serializable, write down the equivalent serial schedule(s).

T_1 : $r_1(X)$; $r_1(Z)$; $w_1(X)$;

T_2 : $r_2(Z)$; $r_2(Y)$; $w_2(Z)$; $w_2(Y)$; (7)

T_3 : $r_3(X)$; $r_3(Y)$; $w_3(Y)$;

S_1 : $r_1(X)$; $r_2(Z)$; $r_1(Z)$; $r_3(X)$; $r_3(Y)$; $w_1(X)$; $w_3(Y)$; $r_2(Y)$; $w_2(Z)$; $w_2(Y)$;

S_2 : $r_1(X)$; $r_2(Z)$; $r_3(X)$; $r_1(Z)$; $r_2(Y)$; $r_3(Y)$; $w_1(X)$; $w_2(Z)$; $w_3(Y)$; $w_2(Y)$;

6. a) What is meant by the term heuristic optimization? Discuss the main heuristics that are applied during query optimization. What is meant by cost-based query optimization? (2+4+2)

b) What is the system log used for? What are the typical kinds of records in a system log? (3)

c) What are check points, and why are they important? (3)

7. a) Describe the wait-die and wound-wait protocols for deadlock prevention. Prove that these protocols avoid starvation. (3+2)

b) What is a phantom record? Discuss the problem that a phantom record can cause for concurrency control. How does index locking resolve the phantom problem? (1+2+2)

c) Prove that the basic two-phase locking protocol guarantees conflict serializability of schedules. (4)