END SEMESTER
CSC-441: Database Systems
International Institute of Information Technology, Hyderabad
Time: 3 hours; Max. Marks: 80

Note: There are 9 questions. Answer all questions. No doubts will be cleared. Pls. make appropriate assumptions.
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1. Consider a transaction T asks bank B to transfer $10,000 from an account at B to an account at another bank C. Consider that T is originated at B and committed by following two phase commit protocol. Discuss how the recovery protocol ensures the transaction to resume correctly if one of the computer, either B or C, crashes while executing two phase commit. [6]

2. Which concepts of CAP theorem are relevant to build NOSQL systems? Discuss. [6]

3. We have a large relation R consisting of 10,000,000 tuples. The tuples are off fixed size length. Each tuple requires 100 bytes. The disk I/O is 15 msec. The system has 50 MB of main memory. Disk block size is 4096 bytes. Estimate the time for sorting a relation using two-phase multiway merge sort assuming that
   (i) The tuples in the original data file are stored in a random order on the disk. After Phase 1, tuples are stored in random order. [2]
   (ii) The tuples in the data file are organized by cylinders. Also, storing of tuples after the first phase can be organized by cylinders. [4]
   (iii) Replacing the disk with four disks. [2]

4. Consider the join of four relations R,S,T and U. Each of R and U have 1000 tuples. Each of S and T have 100 tuples. The attributes and estimated sizes of value sets for the attributes in each relations are summarized as below. Apply greedy algorithm and estimate the cost of the join order. [6]

R(a,b)	S(b,c)	T(c,d)	U(d,a)
V(R,a)=100			V(U,a)=50
V(R,b)=200	V(S,b)=40		
	V(S,c)=50	V(T,c)=20	
		V(T,d)=50	V(U,d)=1000

5. Consider the following sequence of log records: <Start S>; <S,A,60>; <Commit S>; <Start T>; <T,A,10>; <Start U>; <U, B, 20>; <T,C,30>; <Start V>; <U,D,40>; <V,F,70>; <Commit U>; <T,E,50>; <Commit T>; <V,B,80>; <Commit V>. Suppose that we begin a nonquiescent checkpoint immediately after the log record " <U,B,20>" is written (in memory). Then tell, (i) when the <CKPT> record is written. (ii) Discuss the recovery steps when crash occurs after writing the log record <T,A,10>, <U,D,40>, and <V,B,80>. [6]

6. Suppose keys are hashed to four-bit sequences and blocks hold three records. If we start hash table with two empty blocks (corresponding to 0 and 1), show the organization after we insert records with the following keys by following extensible hashing: 0000, 0001,….,1111. [6]

7. Consider the schedule of transactions T_1, T_2, and T_3:

   $r_1(A); r_2(B); r_3(C); r_1(B); r_2(C); r_3(A); w_1(A); w_2(B); w_3(C);$

   (i) Insert shared and exclusive locks, and insert unlock actions. Place a shared lock immediately in front of each read action that is not followed by a write action of the same element by the same transaction. Place an exclusive lock in front of every other read or write action. Place the necessary unlocks at the end of every transaction.

. Tell what happens (i.e., which locks are denied and which locks are accepted) which when each schedule is run by a scheduler that supports shared and exclusive locks. (Depict the schedule with a table) [2]

(ii) Insert shared and exclusive locks in a way that allows upgrading. Place a shared lock in front of every read, and exclusive lock in front of every write, and place the necessary unlocks at the ends of the transactions.

Tell what happens (i.e., which locks are denied and which locks are accepted) when it is run by a scheduler that supports shared locks, exclusive locks and upgrading. (Depict the schedule with a table) [2]

(iii) Is there any advantage due to upgrading ? Discuss. [2]

8. Consider an object-oriented database. The objects of class C are stored on two blocks, B1 and B2. Block B1 contains objects O1 and O2, while block B2 contains object O3, O4, and O5. Class extents, blocks and objects form a hierarchy of lockable database elements. Tell the sequence of lock requests and the response of a warning-protocol-based scheduler to the following sequence of lock requests: $r_1(O_1)$; $r_2(O_2)$; $r_3(O_1)$; $w_1(O_3)$; $w_2(O_4)$; $w_3(O_5)$; $w_1(O_2)$; [6]

9. Briefly explain the following [10*3=30]

9.1 Explain how REDO logging saves disk I/Os as compared to UNDO logging.

9.2 Discuss why Selinger-style optimization could give better optimal plans over dynamic programming.

9.3 Justify that every conflict-serializable schedule is view serializable, and every view serializable schedule is not conflict serializable.

9.4 Explain the modifications required to 2PL to ensure recoverable schedules and the corresponding issue. How group commit improves the performance ?

9.5 Parallelism is natural to DBMS. Justify.

9.6 Database-system implementers have paid much more attention to the ACID properties than have file-system implementers. Why this might be the case ?

9.7 What is the purpose of commit bit in timestamp ordering protocol ? Explain the issue if we do not use the commit bit.

9.8 Many transactions update the cash balance at a bank and individual account balances. List the concurrency protocols you have studied (no explanation) and explain which protocol increases the concurrency and throughput?

9.9 Suppose you have been asked to develop a recovery system to manage a disaster (For example, fire and floods). Briefly list the steps of recovery manager during normal processing and after the disaster.

9.10 Justify the following: *"The number of possible left-deep trees with a given number of leaves is large, but not nearly as large as the number of all trees."*