1. The Undo, No Redo algorithm has the following description: Transactions First transfer before-images of each page to the audit trail and then put the after-images in the database.
Suppose we changed it so that we transfer the after-image to the database before putting the before-image to the audit trail. Will this be correct? Prove your answer.

2. Suppose that a transaction manager has done the following steps in the two phase commit protocol for a transaction T:
   (a) It has asked all servers whether they are willing to commit and they all responded affirmatively.
   (b) It has sent a message to all servers to commit, but has not yet received a response from all of them.

Does the transaction manager still need to keep a record of transaction T? If not, why not? If so, for how long?

3. Suppose we are trying to decide whether to put a non-clustering index on attribute B for relation R to support equality selections on B. The relation has 10 million records. Each page can store 10 records. There are 100 different values of B. A sequential scan will fetch 10 pages per read. How many reads would an index search cost? How many reads would a table scan cost? Explain why you would or would not want to include a non-clustering index.

4. Suppose that each of relations R, S, T, V, W has A as its only key. Which of the following queries may output a different number of records if DISTINCT is removed? Prove your answer.

   a. SELECT DISTINCT R.A, S.A
      FROM R, S
      WHERE R.B = S.C

   b. SELECT DISTINCT R.A
      FROM R, S
      WHERE R.B = S.C

   c. SELECT DISTINCT R.A
      FROM R, S
      WHERE R.B = S.A

   d. SELECT DISTINCT R.A
      FROM R, S, T, V, W
      WHERE R.B = S.A
      AND R.D = T.D
      AND R.C = V.A
      AND T.A = S.B
      AND W.A = S.D

   e. SELECT DISTINCT R.A
FROM R, S, T
WHERE R.B = T.A
AND R.B = S.C

5. Suppose that the following four transactions are the only ones that execute during some interval (R stands for read, W for write, and different letter arguments represent different data items).

T1: R(A) W(E) R(C) W(D) W(B)
T2: W(A) W(B)
T3: R(D) R(C)
T4: R(A) R(E)

a. What is the finest chopping of T1 assuming that its reads and writes cannot be reordered? Show the chopping.

b. What is the finest chopping of T1 assuming that its non-conflicting writes can be reordered (but no write can be moved past a read, because it might depend on that read)? Show the reordering, then the chopping.

c. Can any other transactions be chopped?

6. Suppose that some single server has an arrival rate of 9 per second, and a service time of 0.1.

a. What is the utilization?

b. What is the response time?

c. What would be the utilization and response time if the server were tuned so the service time were reduced to 0.05?

d. What would be the response time if the single server service time remained at 0.1 but a new server were added (so two servers altogether)?

e. What would be the response time if the single server service time remained at 0.1 but three new servers were added (so four servers altogether)?