Exercise 1: Assume a *deferred* database modification scheme. Consider the following example of redo log for two transactions.

1. (Start, T1);
2. (Write, T1, Q, 100);
3. (Commit, T1);
4. (Start, T2);
5. (Write, T2, P, 55);
6. (Commit, T2);

Consider the following two cases:

- Case 1: The schedule crashes after Step 5 and before Step 6, and the recovery completes successfully.
- Case 2: The schedule crashes after Step 5 and before Step 6, and the recovery process starts. During recovery process, the schedule crashes after Step 2 and before Step 3.

What actions (Redo/No action) must be done on the transactions for the two cases?

Exercise 2: Assume an immediate database modification scheme. Consider the following log consisting of transactions T1, T2, and T3.

1. (Start, T1);
2. (Write, T1, P, 500, 600);
3. (Write, T1, Q, 400, 500);
4. (Commit, T1);
5. (Start, T2);
6. (Write, T2, P, 600, 550);
7. (Write, T2, Q, 500, 450);
8. (Commit, T2);
9. (Start, T3);
10. (Write, T3, P, 550, 600);
11. (Write, T3, Q, 450, 500);
12. (Commit, T3);

(a) If the schedule crashes just after the Step 3, what recovery operations will be performed?

(b) If the schedule crashes just after the Step 7, what recovery operations will be performed?
(c) If the schedule crashes just after Step 11, then after the complete recovery process the value of P and Q will be?

Exercise 3: Consider the following log file, created in a basic checkpointing recovery protocol environment:

(start T1); (W1. A, 2, 3); (start T2); (W2, B, 4, 5); (W1, B, 5, 6); (start T3); (commit T1); (W3, A, 3, 6); (Checkpoint, T3, T2); (start T4); (W4, A, 6, 7); (W3, A, 7, 9); (W4, B, 6, 7); (commit T4); (start T5); (W5, A, 9, 4);

If the system crashes now, what is the correct order of recovery operations using undo-list and redo-list?

Exercise 4: Consider a database that has six elements - A, B, C, D, E and F. The initial values of the elements are:

A = 10, B = 20, C = 30, D = 40, E = 50, F = 60

Let there be three transactions U, V and W that modify these elements concurrently.

- U: A := 5, B:= 15, D := 30
- V: C := 25
- W: E := 35, F:=45

While the elements are being modified by the transactions, the database system crashes. The recovery mechanism depends on the logging scheme we use. In the questions below, we present the contents of the log at the time of crash when the logging scheme used is **steal/no force.** (For each log entry we give the relevant data)

< START U > ;< U, A, 10, 5 >; < START V >; < U, B, 20, 15 >; < V, C, 30, 25 > ;< COMMIT V >; < START CKPT >; < START W >; < U, D, 40, 30 > ;< W, E, 50, 35 >; < END CKPT >; < W, F, 60, 45 >

a) Is the following state of database elements (on disk) possible at the time of crash? Justify your answer.

b) What are the values of the database elements (A=?, B=?, C=?, D=?, E=?, F=?) after a successful recovery?

What different compensation log records will be written in the log during recovery?

Exercise 5: Consider the following sequence of log records in the log file before the system crashed: (start T1), W1(A, 3, 4), W1(B, 1, 2), (commit T1), (start T2), W2(B, 2, 7), W2(A, 4, 8), system crash Which of the following would be the recovery sequence in the immediate database modification scheme?
A. Undo T2{A:=4, B:=2}, Redo T1{A:=4, B:=2}
B. Redo T1{A:=4, B:=2}, Undo T2{A:=4, B:=2}
C. Redo T1{A:=4, B:=2}, Redo T2{B:=7, A:=8}
D. Undo T2{A:=4, B:=2}, Undo T1{B:=1, A:=3}

Exercise 6: Consider the following log file, created in a basic check pointing recovery protocol environment: (start T1); (W1,A,2,3); (start T2); (W2,B,4,5); (W1,B,5,6); (start T3); (commit T1); (W3,A,3,6); (Checkpoint, T3,T2); (start T4); (W4,A,6,7); (W3,A,7,9); (W4,B,6,7); (commit T4); (start T5); (W5,A,9,4); If the system crashes now, what is the correct order of recovery operations using undo-list and redo-list?

A. Redo:{(T4,A:=7);(T4,B:=7)}; Undo:{(T5,A:=9);(T3,A:=7);(T2,no op)}
B. Redo:{(T4,A:=7);(T3,A:=9);(T4,B:=7);(T5,A:=4)}
C. Undo:{(T5,A:=9);(T3,A:=7);(T2,no op)}; Redo:{(T4,A:=7);(T4,B:=7)}
D. Undo:{(T5,A:=9);(T4,B:=6);(T3,A:=7);(T4,A:=6)}

Exercise -7 Give brief explanation about deferred updates.