

	<b>Course:</b> <b>Program:</b> <b>Instructor:</b>	<b>Advance Database Concepts</b> <b>BS (Computer Science)</b> <b>Muhammad Ishaq Raza</b>
	<b>Practice Problems:</b>	<b>DB Recovery Techniques</b>

**SOLUTION**

**Topic: Database Recovery Techniques**

**Q1.** Consider the following log corresponding to a particular schedule at the point of a system crash for five transactions. Suppose that we use the immediate update (undo/redo) protocol with *checkpointing*. Describe the recovery process from the system crash. Assume that the initial values of items are  $X=50$ ,  $Y=100$ , and  $Z=150$ . Isolation level of all transactions is *READ COMMITTED*.

- Identify which transactions need undo/ redo operation(s)?
- Specify which operations in the log are redone (in correct order) and which are undone.
- Write down the values of items X, Y, and Z after system recovery.

- [start\_transaction, T1]
- [read\_item, T1, Y, 100]
- [start\_transaction, T2]
- [read\_item, T2, X, 50]
- [write\_item, T2, X, 50, 25]
- [read\_item, T2, Y, 100]
- [write\_item, T2, Y, 100, 125]
- [commit, T2]
- [start\_transaction, T3]
- [read\_item, T1, X, 25]
- [write\_item, T1, X, 25, 10]
- [read\_item, T3, Z, 150]
- [write\_item, T3, Z, 150, 125]
- [checkpoint]**
- [commit, T3]
- [start\_transaction, T4]
- [read\_item, T4, Z, 125]
- [start\_transaction, T5]
- [read\_item, T5, Z, 125]
- [write\_item, T5, Z, 125, 110]
- [commit, T5]
- System crash**

**Ans:**

- T2 was committed before the checkpoint and hence is not involved in the recovery.  
 - The list of committed transactions T since the last checkpoint contains transactions T3 and T5. Hence T3 and T5 need redo operations.  
 - The list of active transactions T' contains transactions T1 and T4. Hence, they are cancelled and must be resubmitted. Hence T1 and T4 need undo operations.
- Only the WRITE operations of the committed transactions (i.e. T3 and T5) are to be redone. Hence, REDO is applied to:  
 [write\_item, T3, Z, 125]  
 [write\_item, T5, Z, 110]  
 - Only the WRITE operations of the cancelled transactions (i.e. T1 and T4) are to be undone. Hence, UNDO is applied to:  
 [write\_item, T1, X, 25]  
 - The transactions that are active and did not commit i.e., transactions T1 and T4 are cancelled and must be resubmitted. Their operations have to be undone.
- After systems recovery, the values of items are  $X=25$ ,  $Y=125$ ,  $Z=110$

**Q2.** Consider the following log at point of crash. Suppose that we use **ARIES recovery algorithm**. Assume that the dirty page table and transaction table were empty before the start of the log.

LSN	Last_LSN	Trans_ID	Type	Page_ID	Other_Info
11	begin checkpoint				
12	end checkpoint				
13	0	T1	update	P3	...
14	0	T2	update	P2	...
15	13	T1	commit		...
16	0	T3	update	P1	...
17	14	T2	update	P3	...
18	17	T2	commit		...
19	16	T3	update	P2	...

- a. What is the value of the LSN stored in the master log record (a special file)?

**Master Log Record:**

LSN

- b. What is done during Analysis? Be precise about the points at which Analysis begins and ends and show the contents of transaction table and dirty page table constructed in this phase.

**Transaction Table**

Trans_ID	LSN	Status

**Dirty Page Table**

Page_ID	LSN

- c. What is done during Redo? Be precise about the points at which Redo begins and ends.

**Redo Phase:**

Begin LSN

End LSN

- d. What is done during Undo? Be precise about the points at which Undo begins and ends.

**Undo Phase:**

Begin LSN

End LSN

Answer:

a. LSN = 11

b. Analysis phase starts from LSN=11 record until it reaches the end i.e. LSN=19.

The end checkpoint contains the empty transaction table and dirty page table. The analysis phase will further reconstruct these tables as follows:

Transaction Table

Trans_ID	LSN	Status
T1	<del>13</del> 15	<del>inProcess</del> commit
T2	<del>14</del> <del>17</del> 18	<del>inProcess</del> commit
T3	<del>16</del> 19	inProcess

Dirty Page Table

Page_ID	LSN
P3	13
P2	14
P1	16

c. REDO begins from LSN=13 (smallest LSN in DPT) and proceed with the REDO of updates. The LSNs {13, 14, 16, 17, 19} corresponding to the updates for pages P3, P2, P1, P3, and P2, respectively, are not less than the LSNs of pages in initial DPT. So those data pages will be read again and all the updates reapplied from the LOG file to database. At this point REDO phase is finished and the UNDO phase starts.

Begin LSN	End LSN
13	19

d. UNDO is applied only to the active transaction T3. UNDO phase starts at LSN=19 (the last update of active transaction T3) and proceeds backward in the LOG. The backward chain of updates for T3 (LSN=19 and LSN=16 records) is followed and undone.

Begin LSN	End LSN
19	16