BSCCS2001: Graded Assignment with Solutions
Week 11

{Write general instructions here}

1. Consider a log of a transaction as shown below, where the immediate database modification scheme is used. [MCQ :3 points]

Step	Details of log
1	$< T_0, start >$
2	$< T_0, A, 1200, 900 >$
3	$< T_0, B, 1000, 800 >$
4	$< T_0, C, 800, 600 >$
5	$< T_0, commit >$

Suppose the transaction failed before step 5, then which of the following is true?

- ◯ T_0 : Undo and log records $< T_0, C, 800 >$, $< T_0, abort >$ are written out.
- ◯ T_0 : Redo and log records $< T_0, A, 1200 >$,$< T_0, B, 1000 >$, $< T_0, C, 800 >$, $< T_0, abort >$ are written out.
- √ T_0 : Undo and log records $< T_0, A, 1200 >$,$< T_0, B, 1000 >$, $< T_0, C, 800 >$, $< T_0, abort >$ are written out.
- ◯ T_0 : Redo and log records $< T_0, C, 800 >$, $< T_0, abort >$

Solution: Undo of a log record $< Ti, X, V1, V2 >$ writes the old value V1 to X
Redo of a log record $< Ti, X, V1, V2 >$ writes the new value V2 to X.
Here, if the transaction fails before step 5, then undo operation will take place and log records $< T_0, A, 1200 >$, $< T_0, B, 1000 >$, $< T_0, C, 800 >$, $< T_0, abort >$ are written out.
So, Option is C is correct.

2. Consider a log of a transaction as shown below, where Rs.300 is transferred from account A to B. Initially account A has Rs.1200 and B has Rs.1000. [MSQ :2 points]

step	Details of log
1	$< T_0, start >$
2	$< T_0, A, 1200, 900 >$
3	$< T_0, B, 1000, 1300 >$

Choose the correct amounts in A and B stored on the disk after Step 3 is completed.

- ◯ In case of deferred database modification scheme, the amount in account A is Rs.900 and B is Rs.1300.
- √ In case of deferred database modification scheme, the amount in account A is Rs.1200 and B is Rs.1000.
- √ In case of immediate database modification scheme, the amount in account A can be Rs.900 and in B can be Rs.1300.
- ◯ In case of immediate database modification scheme, the amount in account A will always be Rs.1200 and B will always be Rs.1000.

Solution:

- The immediate-modification scheme allows updates of an uncommitted transaction to be made to the disk itself, before or after the transaction commits. So, even if the transaction is not committed, the amount in account A can be Rs.900 and B can be Rs.1300.
  But since in immediate-modification scheme, it is not compulsory to output the changes to the disk before the commit takes place. Therefore, the amount in A and B can be Rs.1200 and Rs.1000 respectively.
- The deferred-modification scheme performs updates to buffer/disk only at the time of transaction commit. But in the given log $< commit >$ is not there, so transaction is not committed, so the amount in account A and B will be unchanged.

3. Consider the following log records of transactions, where immediate database modification scheme is used. [MCQ:3points]

step	Details of log
1	$< T_0, start >$
2	$< T_0, A, 1200, 900 >$
3	$< T_0, B, 1000, 800 >$
4	$< T_1, start >$
5	$< T_1, D, 200, 50 >$
6	$< T_0, commit >$
7	$< T_2, start >$
8	$< T_2, P, 700, 300 >$
9	$< checkpointL >$
10	$< T_2, Q, 1150, 670 >$
11	$< T_1, E, 400, 320 >$
12	$< T_1, commit >$
13	$< checkpointL1 >$
14	$< T_2, R, 300, 100 >$

If a crash occurs just after step 14, then which of the following actions is correct?

- ◯ T_0 : No action, T_1 : Undo and T_2 : Undo
- √ T_0 : No action, T_1 : No action and T_2 : Undo
- ◯ T_0 : No action, T_1 : Redo and T_2 : Undo
- ◯ T_0 : Redo, T_1 : Redo and T_2 : Undo

Solution: The immediate-modification scheme allows updates of an uncommitted transaction to be made to the buffer, or the disk itself, before the transaction commits.
In a given log, the crash had occurred after step 14, till here T_0 and T_1 are committed. So, no action will be taken on T_0 and T_1.
Also, $< checkpointL1 >$ is present at step 13, so we need to modify the log that happened after $< checkpointL1 >$.
Since, it is immediate modification scheme, at step 14 $< T_2, R, 300, 100 >$, the value of R is already updated to the disk, so we need to do **undo** operation here.
So, option 2 is correct.

4. Consider the following statements.

    1. Differential backup targets only those files or items that have changed since the last backup.
    2. Incremental backup backs up all the changes that have occurred since the most recent full backup.

    Choose the correct option. [MCQ:2 points]

    - ◯ Both the statements are correct.
    - √ Both the statements are wrong.
    - ◯ Statement 1 is correct and statement 2 is wrong.
    - ◯ Statement 1 is wrong and statement 2 is correct.

    Solution:

    1. Incremental backup targets only those files or items that have changed since the last backup.
    2. Differential backup, backs up all the changes that have occurred since the most recent full backup. **Refer to slide no 51.14, 51.16 and 51.19**

5. Which of the following backup is static in nature and is available 24x7? [MCQ: 2 points]

- ◯ Hot Backup
- ◯ Cold Backup
- ◯ Both
- √ None of the above

Solution:

1. Hot Backup is dynamic in nature and is available 24*7.
2. Cold Backup is static in nature and is available once the database operations are stopped completely.
   Refer to Slide 53.6.

Consider the given backup schedule, and answer the question.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Incremental	*Incremental*	------	*Incremental*	*Incremental*	*Full*	*Incremental*

Figure 1: .

6. Assume that on Wednesday 'Differential Backup' is done. In this scenario how many backup sets have to be loaded for a complete recovery if the system failure occurs after Friday's backup is completed?

[NAT: 4 points]

Ans: 4

Solution: For complete recovery the required sets are: Full backup set of previous Saturday, the differential backup set of Wednesday, 2 incremental backup sets of Thursday and Friday.

7. A RAID-3 system has 8 disks in total and a RAID-4 system has 5 disks in total. What is the minimum number of blocks that can be transferred for RAID-3 and RAID-4 system respectively?
Note: The smallest atomic unit of data transfer is one block

[Bhaskar:4 points:MCQ]

- ◯ RAID-3= 1 block, RAID-4= 4 blocks
- ◯ RAID-3= 7 blocks, RAID-4= 4 blocks
- ◯ RAID-3= 8 blocks, RAID-4= 5 blocks
- √ RAID-3= 7 blocks, RAID-4= 1 block

Solution:
RAID-3 uses byte level striping. This means that the bytes of a chunk/block of data is stored consecutively on successive disks, hence whenever a data block has to be referenced all disks must participate in the read operation since the data is present as parts(bytes) in all the disks. So RAID-3 system with k disks will have k-1 data disks and thus k-1 disks participate whenever data transfer occurs. Now, the minimum data unit that can be read from a disk is a block so in a RAID-3 read operation, the minimum transferrable unit is k-1 blocks. In our case it is $8-1=7$ blocks.

RAID-4 uses block level striping and hence each block can be read independently from respective disk. So minimum transfer unit in RAID-4 is 1 block.
Hence option 4 is correct.

8. A RAID-4 system with 5 disks stores the name of Arvind's alma mater
Block A of disk-1 stores 1001001,
Block A of disk-2 stores 1001001,
Block A of disk-3 stores 1010100,
Block A of disk-5 stores 0011111
Disk-4 got corrupted and disk-5 is the Parity disk. Considering that the binary number in each block is representation of an ASCII character, which one of the following is Arvind's alma mater?
Note: Assume in this hypothetical system the block size is 7 bits

[Bhaskar:4 points:MCQ]

- ◯ IIMC
- √ IITK
- ◯ IITM
- ◯ IIMA

Solution:
RAID-4 systems uses bitwise XOR recovery functionality to recover lost data due to disk failure.
Data of disk 4 = disk-1 data XOR disk-2 data XOR disk-3 data XOR disk-5 parity.
Therefore data of disk-4
=1001001 XOR 1001001 XOR 1010100 XOR 0011111 = 1001011 = 75 (in decimal).
In ASCII representation 75 means 'K'. Disk-1 and disk-2 stores the letter 'I' since 1001001 = 73(in decimal) = 'I' in ASCII. Likewise disk-3 stores 'T' since 1010100 = 84 which corresponds to 'T' in ASCII.
Hence option 2 is correct.

9. Given a RAID-1 and a RAID-4 system both with 7 disks in total, what is the storage efficiency for these two storage systems.

Note: Storage Efficiency $= \frac{Number\ of\ non-redundant\ data\ disks}{Total\ number\ of\ disks}$

[Bhaskar:4 points:MCQ]

- √ RAID-1= 50%, RAID-4= 85.71%
- ◯ RAID-1= 100%, RAID-4= 85.71%
- ◯ RAID-1= 50%, RAID-4= 100%
- ◯ RAID-1= 100%, RAID-4= 50%

Solution:
RAID-1 follows Mirroring strategy for storage, so two sets of the same data is stored separately as redundant copies. Hence irrespective of number of disks the storage efficiency is 50%
RAID-4 has one disk as parity disk all other are data disks. Storage efficiency means the ratio of the amount of resource (disk space) used for storing data to the total resource (disk space) in the system.
So RAID-4 storage efficiency would be $= 6/7 * 100 = 85.71\%$.
Hence option 1 is correct.

10. Consider the following statements. [MCQ:2 points]

1. In RAID 2, the Hamming code is used for parity.
2. RAID 4 has a striping unit of a disk block instead of a single bit.
3. The Write performance of RAID 5 is poorer than that of RAID 6.
4. RAID 10 provides better throughput and latency than all other RAID levels except RAID 0.

◯ Statements 1, 2 & 3 are correct

◯ Statements 1 & 3 are correct

◯ Statements 1, 3 & 4 are correct

√ Statements 1, 2 & 4 are correct

Solution:

- In RAID 2, hamming code is used for parity.
- RAID 4 has a striping unit of a disk block instead of a single bit.
- The **Write** performance of **RAID 6** is poorer than that of **RAID 5**
- RAID 10 provides better throughput and latency than all other RAID levels except RAID 0.