GEORGIA INSTITUTE OF TECHNOLOGY
CS 6423: DATABASE SYSTEM IMPLEMENTATION PART II (SPRING 2025)

Exercise Sheet 1
Version 1.1
Due: **Feb 20, 2025 @ 11:59pm**

IMPORTANT:

- **Plagiarism**: Homework may be discussed with other students, but all homework is to be completed **individually**.
- **Submission**: Upload the PDF with your answers to **Gradescope**.
- **Answers**: For the subjective questions, answer briefly. We prefer **bulleted lists** with brief points.
- **You have to use this PDF for all of your answers.**

For your information:

- Graded out of **130** points; **3** questions total

Question	Points	Score
Recovery Protocol	40	
Logging Protocol	70	
SiloR protocol	20	
Total:	130	

Question 1: Recovery Protocol.....[40 points]

(a) Consider a DBMS system that uses ARIES recovery protocol. The table below shows the log records that were read in from the master record on disk during recovery (starting from the most recent successful checkpoint). In the checkpoint record, each transaction in the Active Transaction Table (ATT) is mapped to its lastLSN and each page in the Dirty Page Table (DPT) is mapped to its recLSN. Here are a couple of references - Reference 1 , Reference 2 that you might find to be useful.

LSN	PrevLSN	TxnID	Type	PageID	ObjectID	Before	After	UndoNext
1	-	T2	-	Begin	Txn	-	-	-
2	1	T2	Update	P2	X	15	18	-
3	2	T2	Update	P2	Y	18	20	-
4	-	T1	-	Begin	Txn	-	-	-
5	3	T2	Update	P4	Z	10	12	-
6	4	T1	Update	P1	W	12	21	-
7	6	T1	Update	P1	V	30	35	-
8	7	T1	Update	P1	U	35	40	-
9	8	T1	Update	P1	B	19	29	-
10	-	-	Checkpoint Begin					
11	-	-	Checkpoint End (ATT $(T1, 9), (T2, 5)$, DPT $(P1, 6), (P4, 5), (P2, 2)$)					
12	9	T1	Update	P3	A	10	11	-
13	5	T2	Update	P4	C	21	23	-
14	13	T2	Update	P5	D	20	30	-
15	14	T2	Commit	-	-	-	-	-
16	-	T3	-	Begin	Txn	-	-	-
17	16	T3	Update	P6	R	52	50	-
18	17	T3	Abort	-	-	-	-	-
19	-	T4	Begin	Txn	-	-	-	-
20	19	T4	Update	P2	T	40	41	-
21	20	T4	Commit	-	-	-	-	-
22	18	T3	CLR	P6	R	50	52	-
23	15	T2	End Txn	-	-	-	-	-

Question 1 continues...

i. **[20 points]** Show the entries in ATT table and DPT table after **Analysis** phase.

ATT

Txn ID	LastLSN	Status

DPT

Page ID	recLSN

ii. **[20 points]** Show the new log records added as part of the **Redo** and **Undo** phases. You can assume that no new transactions were logged during the recovery phase.

Question 1 continues…

Question 2: Logging Protocol.....[70 points]

(a) The shadow-paging scheme requires the entire page table to be copied. You can assume that the page table is represented as a copy-on-write B+-tree.

i. **[10 points]** Explain how to share as many nodes as possible between the master and the shadow copy of the B+-tree, assuming that updates are made only to leaf entries, with no insertions or deletions.

ii. **[10 points]** Consider a transaction that performs a few small updates. Is the write ahead logging protocol slower than the shadow paging protocol? Justify your answer.

(b) **[10 points]** Physiological logging can reduce the logging overhead significantly compared to physical logging. Explain why that is the case with a concrete example.

(c) Describe the logging protocol for these buffer management policies:

i. **[10 points]** NO-STEAL + FORCE

ii. **[10 points]** STEAL + NO-FORCE

iii. **[10 points]** NO-STEAL + NO-FORCE

(d) **[10 points]** Explain why it is challenging to support concurrent txn processing with logical logging.

Question 2 continues…

Question 3: SiloR protocol.....[20 points]

These questions are based on the SiloR system.

(a) **[10 points]** Explain how SiloR supports log replay at roughly the maxi-mum speed of I/O.

(b) **[10 points]** Why does value logging work without having to know the exact serial order?