Department of Computer Science

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Advanced Databases — Exam
Winter Semester 2024/25 — 26.02.2025

Name: ______________________ **Student ID:** ______________________

Hints

- Check whether you received all pages of the exam (9 pages).
- Write your name or your student ID on each sheet of the exam and hand in all pages.
- All answers are expected to be written on the exam sheets.
- Clearly highlight and enumerate additional pages that are used for longer answers. Match your text with the according exercise.
- Only use pencils that are permanent and non-red colored.
- Use the notation and techniques discussed in the lecture.
- Exercises with more than one solution are not graded.
- You are allowed to use one A4 sheet with your personal notes (both sides, hand written or printed).
- Exam duration: 90 minutes

Signature ______________________

Grading — Filled by the examiner

Exercise	1	2	3	4	5	6	7	8	Sum
Total points	1	1	1	1	1	1	1	1	8
Points reached									

Exercise 1 1 Point

Identify which of the properties: **conflict serializable**, **recoverable**, **cascadeless**, are fulfilled by the following schedule. If a property is not fulfilled, explain why.

T1:	T2:	T3:	T4:
read(A)			
write(A)			
		read(C)	
	write(B)		
	write(C)		
		read(A)	
			read(B)
read(A)			
	COMMIT		
		write(A)	
			write(B)
			COMMIT
read(B)			
COMMIT			
		COMMIT	

Exercise 2 1 Point

Consider a new locking protocol 2PL$^+$ that extends two-phase locking (2PL) and permits *downgrading* an exclusive lock to a shared lock in all phases of the protocol. In 2PL$^+$, a transaction that has an exclusive lock on an item `X` can use the operation `downgrade(X)` to downgrade its exclusive lock on `X` to a shared lock on `X`.

Prove or disprove the following statement: Protocol 2PL$^+$ ensures *conflict-serializable* schedules.

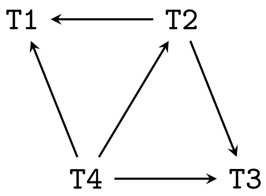
Exercise 3 1 Point

Consider the following graph in which a directed edge `Ti`→`Tj` indicates that `Ti` requests a lock currently held by `Tj`.

(a) Which of the transactions would be rolled back under the **wound-wait** deadlock prevention strategy?

(b) With what timestamp is the rolled-back transaction restarted and why?

Transaction timestamps are equal to their numeric identifiers, i.e., `Ti` has timestamp i. Older transactions have smaller timestamps.



Exercise 4

1 Point

Consider the **snapshot isolation** concurrency control scheme and the following transactions. Explain the *first committer wins* and *first updater wins* rules in this scenario, can both transactions commit? Why (not)? Without any rule, which anomaly would occur in this case?

T1:	T2:
read(A)	
	read(A)
read(B)	
write(B)	
	read(B)
	write(B)
	COMMIT
COMMIT	

Exercise 5 1 Point

Consider the following schedule and the **validation based** scheduler.

T1:	T2:	T3:	T4:
	start		
start			
validate			
finish			
			start
		start	
	validate		
	finish		
		validate	
		finish	
			validate
			finish

The objects in the database that can be read or written are: A, B, C, D, E, F. The read and write sets of the transactions are:

T1:	R-set(T1)={A,C},	W-set(T1)={D,F}
T2:	R-set(T2)={A,B},	W-set(T2)={B,D}
T3:	R-set(T3)={C,E},	W-set(T3)={B,F}
T4:	R-set(T4)={E,F},	W-set(T4)={B,E}

Which of the four transactions cannot be committed? State which condition is violated.

Exercise 6 1 Point

Consider the following schedule. Indicate what happens when the schedule is processed by a **multiversion timestamp-ordering** scheduler. The transactions start in order with TS(T1)=1, TS(T2)=2, TS(T3)=3, TS(T4)=4. Assume that initially no versions of data item A exist. State if a transaction must be rolled back and also state if the rollback of a transaction triggers a cascading rollback.

T1:	T2:	T3:	T4:
write(A)			
			write(A)
		read(A)	
	write(A)		

Exercise 7 — 1 Point

Consider the following database object hierarchy and the multi-granularity locking scheme.

```
                ________DB________
              /                    \
         __A1___                   __A2___
       /         \               /         \
     Fa            Fb          Fc           Fd
   / |  \       /  |  \      /  |  \      /  |  \
ra1 ra2 ra3  rb1 rb2 rb3  rc1 rc2 rc3  rd1 rd2 rd3
```

Given are the following four transactions:

T1: Read record rc1.
T2: Modify all records in file Fb.
T3: Read all files in area A2.
T4: Modify record rc3.

1. Indicate the respective locks obtained by transactions T1, T2, T3, T4.

2. Which pairs of transactions T1, T2, T3, T4 **cannot** be executed concurrently?

Exercise 8 1 Point

With the following starting values:

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

write the log file (physical logging) for the following schedule including the log records generated during recovery.

```
T1:         T2:         T3:
start
read(A)
A:=A-5
write(A)
            start
            read(C)
read(B)
B:=B-5
write(B)
read(D)
            C:=C+15
            write(C)
            COMMIT
----------CHECKPOINT------------
                        start
                        read(E)
D:=D-10
write(D)
                        E:=E-15
                        write(E)
                        read(F)
                        F:=F-15
                        write(F)
------------CRASH---------------
```