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Exercise 1

1 Point

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

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

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Exercise 2

1 Point

Is the following schedule **conflict serializable**? Draw the precedence graph to verify. If it **is not**, explain why. If it **is**, give an equivalent serial schedule.

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

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Exercise 3

1 Point

Is the following schedule in a **deadlock state**? Draw the wait-for graph to verify. If it is in a a deadlock state, propose a way to recover from the deadlock.

T1:	T2:	T3:
lock-S(A)		
read(A)		
		lock-X(B)
		lock-S(A)
	lock-X(C)	
		read(A)
lock-X(B)		
	read(C)	
	lock-X(A)	
		lock-S(C)

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Exercise 4

1 Point

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Does the following schedule adhere to the **two phase locking (2PL)** protocol (without the lock conversions)? If **yes**, show the schedule with all required lock and unlock instructions. If **not**, explain why 2PL is violated.

T1:

T2:

T3:

---

read(C)

read(A)

write(B)

read(B)

write(A)

---

Consider the following schedule.

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

Answer the following questions.

1. Does T1 successfully validate?
2. Suppose that the validation of T4 and all previous validations succeeded. What could have been the largest read set of T4?

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Exercise 6

1 Point

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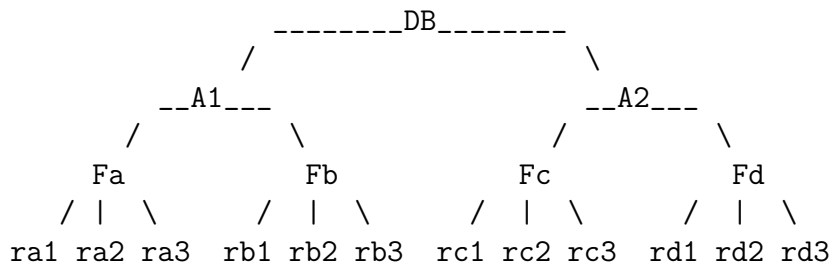
Consider the following log.

1. Which event has triggered the log record in line 10?
2. What would happen during the recovery if the system crashes at the end of the log? Indicate the generated log records.

```
1 <T1, start>
2 <T1, D, 10, 20>
3 <T1, commit>
4 <T4, start>
5 <T4, A, 0, 20>
6 <checkpoint, {T4}>
7 <T2, start>
8 <T2, C, 15, 25>
9 <T3, start>
10 <T4, A, 0>
11 <T3, B, 20, 30>
12 <T2, commit>
-----CRASH-----
```

Consider the following database object hierarchy and the multi-granularity protocol.

Hierarchy of database elements:



Given are 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?



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Exercise 8

1 Point

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Give an example of a schedule that adheres to the **multiversion timestamp ordering** protocol **but not** to the **timestamp ordering** protocol. Explain your answer.