The assignment should be done in groups of two students. You must turn in the source code of your program through Canvas. Each group must submit only one file that contains the full name, OSU email, and ONID of every member of the group.

1: Serializability and 2PL (4 points)

(a) Consider the following classes of schedules: serializable and 2PL. For each of the following schedules, state which of the preceding classes it belongs to. If you cannot decide whether a schedule belongs in a certain class based on the listed actions, explain briefly. Also, for each 2PL schedule, identify whether a cascading rollback (abort) may happen. A cascading rollback will happen in a schedule if a given transaction aborts at some point in the schedule, and at least one other transaction must be aborted by the system to keep the database consistent.

The actions are listed in the order they are scheduled and prefixed with the transaction name. If a commit or abort is not shown, the schedule is incomplete; assume that abort or commit must follow all the listed actions.

1. T1:R(X), T2:R(Y), T3:W(X), T2:R(X), T1:R(Y)
2. T1:R(X), T1:R(Y), T1:W(X), T2:R(Y), T3:W(Y), T1:W(X), T2:R(Y)
3. T1:W(X), T2:R(X), T1:W(X)
4. T1:R(X), T2:W(X), T1:W(X), T3:R(X)

2: Degrees of Consistency (1 point)

(a) Consider the schedule shown in Table 1.

	T1	T2
0	start	
1	read X	
2	write X	
3		start
4		read X
5		write X
6		Commit
7	read Y	
8	write Y	
9	Commit	

Table 1: Transaction schedule

What are the maximum degrees of consistency for T1 and T2 in this schedule? You must find the maximum degrees of consistency for T1 and T2 that makes this schedule possible.

3: Degrees of Consistency (3 point)

The degrees of consistencies supported in MySQL are called *isolation levels*:
https://dev.mysql.com/doc/refman/8.0/en/innodb-transaction-isolation-levels.html

Describe each degree of consistency in MySQL briefly and explain its equivalent degree of consistency explained in the class if such a degree exists.

4: Recovery and ARIES (2 points)

In this problem, you need to simulate the actions taken by the ARIES algorithm. Consider the following log records and buffer actions:

time	LSN	Log	Buffer actions
0	00	update: T1 updates P7	P7 brought in to the buffer
1	10	update: T0 updates P9	P9 brought into the buffer; P9 flushed to disk
2	20	update: T1 updates P8	P8 brought into the buffer; P8 flushed to disk
3	30	begin_checkpoint	
4	40	end_checkpoint	
5	50	update: T1 updates P9	P9 brought into the buffer
6	60	update: T2 updates P6	P6 brought into the buffer
7	70	update: T1 updates P5	P5 brought into the buffer
8	80	update: T1 updates P7	P6 flushed to disk
9		CRASH RESTART	

(a) For the actions listed above, show Transaction Table (XT) and Dirty Page Table (DPT) after each action. Assume that DPT holds pageID and recLSN, and XT contains transID and lastLSN.

(b) Simulate Analysis phase to reconstruct XT and DPT after the crash. Identify the point where the Analysis phase starts scanning log records and show XT and DPT after each action.

(c) Simulate Redo phase: first identify where the Redo phase starts scanning the log records. Then, for each action identify whether it needs to be redone or not.

5: Recovery and ARIES (2 point)

The algorithm used in MySQL for crash recovery is explained at
https://dev.mysql.com/doc/refman/8.0/en/innodb-recovery.html#innodb-crash-recovery

Explain the similarities and differences between this algorithm and ARIES algorithm.