COMPUTER SCIENCE

Database Management System

Transaction & Concurrency Control

Lecture_3

Vijay Agarwal sir

TOPICS TO BE COVERED

01 Serializable Schedule

02 Conflict & View Serializable

Transaction Concept

ACID Properties.

Schedule

Serial Schedule $\Rightarrow n!$ always Consistent

Non serial Schedule

Serializable Schedule.

- Conflict Serializable
  - ✓ Basic Concept
    - Non Conflict (Swapping of Ins
  - ✓ Testing Method (Precedence Graph Method)
  - Conflict Equal to Any serial Schedule.
- View Serializable

Testing for Conflict Serializablity

Precdence Graph Method

Directed graph $G(V,E)$

V: Set of Transaction

E: Edge (Directed edge)

when Conflict Instruction

CNC

Cycle

Not

Conflict Serializable.

Let T_1 transfer 100 Rs from A to B, and T_2 transfer 10% of the balance from A to B.

Schedule 1

T_1	T_2
read (A)	
A: = A – 100	
write (A)	
read (B)	
B: = B + 100	
write (B)	
commit	read (A)
	temp := A * 0.1
	A := A – temp
	write (A)
	read (B)
	B := B + temp
	write (B)
	Commit

1710
+ 3290
5000
Consistent

$S_1 < T_1 T_2 >$

Serial schedule in which T_1 is followed by T_2:

Schedule 2

T_1	T_2
	read (A)
	temp := A * 0.1
	A := A – temp
	write (A)
	read (B)
	B := B + temp
	write (B)
read (A)	Commit
A: = A – 100	
write (A)	
read (B)	
B: = B + 100	
write (B)	
commit	

A:1700
+ B:3300
5000
Consistent.

$S_2 < T_2 T_1 >$

serial schedule where T_2 is followed by T_1

Schedule 3

T$_1$	T$_2$
read (A)	
A: = A – 100	
write (A)	
	read (A)
	temp := A * 0.1
	A := A – temp
	write (A)
read (B)	
B: = B + 100	
write (B)	
commit	
	read (B)
	B := B + temp
	write (B)
	Commit

A:1710
B:3290
$\overline{5000}$
Consistent
=S1(T1,T2)

C$_1$

Schedule 4

T$_1$	T$_2$
read (A)	
A: = A – 100	
	read (A)
	temp := A * 0.1
	A := A – temp
	write (A)
write (A)	
read (B)	
B: = B + 100	
write (B)	
commit	
	read (B)
	B := B + temp
	write (B)
	Commit

$\boxed{C_2}$

1900
+ 3300
$\overline{5200}$
Inconsistent

X

C$_2$

Q.1 Consider the following schedules involving two transactions. Which one of the following statements is TRUE?

S_1: $r_1(X); r_1(Y); r_2(X); r_2(Y); w_2(Y); w_1(X)$

S_2: $r_1(X); r_2(X); r_2(Y); W_2(Y); r_1(Y); w_1(X)$

[2007: 2 Marks]

A Both S_1 and S_2 are conflict serializable

B S_1 is conflict serializable and S_2 is not conflict serializable

[✓ C] S_1 is not conflict serializable and S_2 is conflict serializable

D Both S_1 and S_2 are not conflict serializable

Q.2

Consider the following four schedules due to three transactions (indicated by the subscript) using read and write on a data item x, denoted by r(x) and w(x) respectively. Which one of them is conflict serializable?

[2014(Set-1): 2 Marks]

~~(A)~~ $r_1(x); r_2(x); w_1(x); r_3(x); w_2(x)$

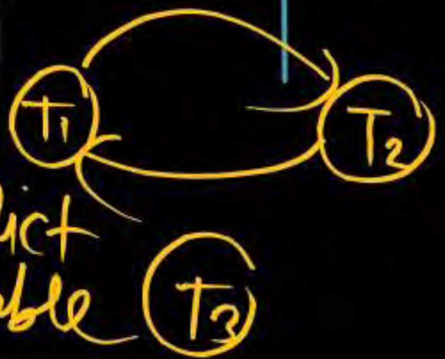
~~(B)~~ $r_2(x); r_1(x); w_2(x); r_3(x); w_1(x)$

~~(C)~~ $r_3(x); r_2(x); r_1(x); w_2(x); w_1(x)$

[✓ (D)] $r_2(x); w_2(x); r_3(x); r_1(x); w_1(x)$

(a)

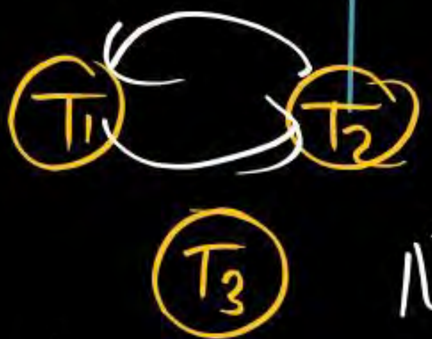
T1	T2	T3
~~r(x)~~		
	r(x)	
w(x)		
		r(x)
	w(x)	



Not conflict serializable

(b)

T1	T2	T3
	r(x)	
r(x)		
	w(x)	
		r(x)
w(x)		



cycle
Not Conflict

Q.2

Consider the following four schedules due to three transactions (indicated by the subscript) using read and write on a data item x, denoted by r(x) and w(x) respectively. Which one of them is conflict serializable?

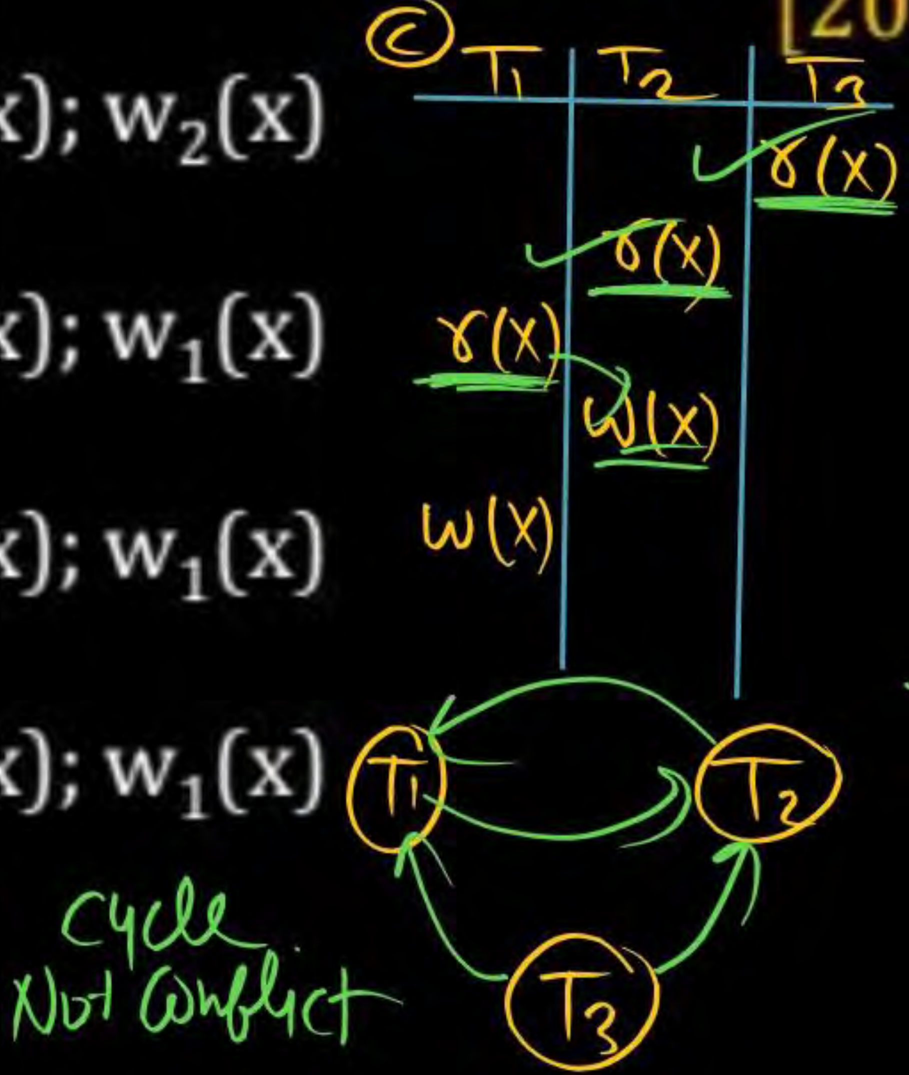
[2014(Set-1): 2 Marks]

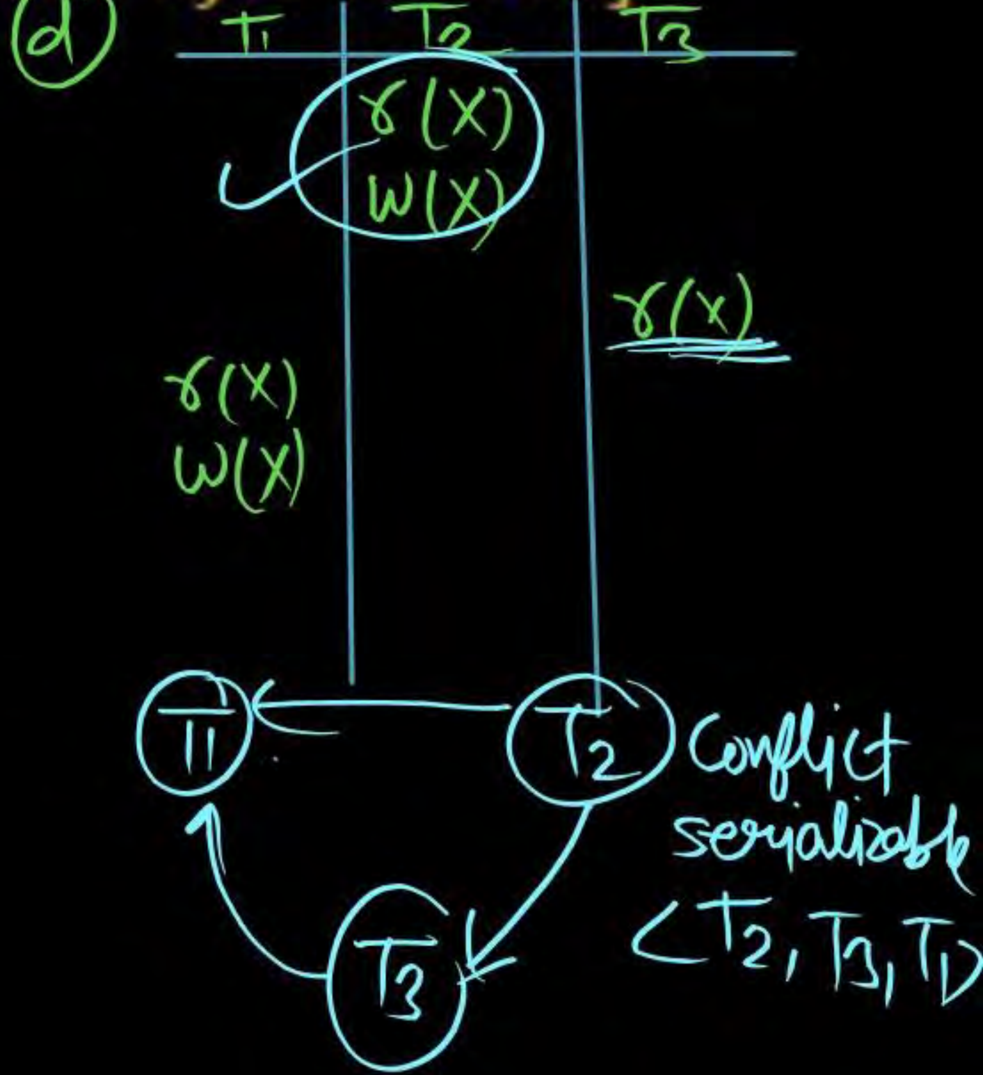
(A) $r_1(x); r_2(x); w_1(x); r_3(x); w_2(x)$

(B) $r_2(x); r_1(x); w_2(x); r_3(x); w_1(x)$

(C) $r_3(x); r_2(x); r_1(x); w_2(x); w_1(x)$

(D) $r_2(x); w_2(x); r_3(x); r_1(x); w_1(x)$ ✓





MCQ Q.3

Consider the transactions T1, T2 and T3 and the schedules S1 and S2 given below.

T1: r1(X); r1(Z); w1(X); w1(Z)
T2: r2(Y) ; r2(Z) ; w2(Z)
T3: r3(Y); r3(X); w3(Y)
S1: r1(X); r3(Y); r3(X); r2(Y); r2(Z); w3(Y); w2(Z); r1(Z); w1(X); w1(Z)
S2: r1(X); r3(Y); r2(Y); r3(X); r1(Z); r2(Z); w3(Y); w1(X); w2(Z); w1(Z)

Which one of the following statements about the schedules is TRUE?

[GATE-2014-CS: 2M]

A Only S1 is conflict-serializable.

B Only S2 is conflict-serializable.

C Both S1 and S2 are conflict-serializable.

D Neither S1 nor S2 is conflict-serializable.

Q.4

Let $r_i(z)$ and $w_i(z)$ denote read and write operations respectively on a data item by a transaction T_i. Consider the following two schedules.

S_1: $r_1(x)\ r_1(y)\ r_2(x)\ r_2(y)\ w_2(y)\ w_1(x)$

S_2:$r_1(x)\ r_2(x)\ r_2(y)\ w_2(y)\ r_1(y)\ w_1(x)$

Which one of the following options is correct? [MCQ: 2021: 2M]

A S_1 is conflict serializable, and S_2 is not conflict serializable.

B S_1 is not conflict serializable, and S_2 is conflict serializable.

C Both S_1 and S_2 are conflict serializable.

D Neither S_1 nor S_2 is conflict serializable.

Q.5 Let $R_i(z)$ and $W_i(z)$ denote read and write operations on a data element z by a transaction T_i, respectively. Consider the schedule S with four transactions.

S: $R_4(x), R_2(x), R_3(x), R_1(y), W_1(y), W_2(x), W_3(y), R_4(y)$

Which one of the following serial schedules is conflict equivalent to S? [2022: 2 Marks]

[✓ A] $T_1 \rightarrow T_3 \rightarrow T_4 \rightarrow T_2$

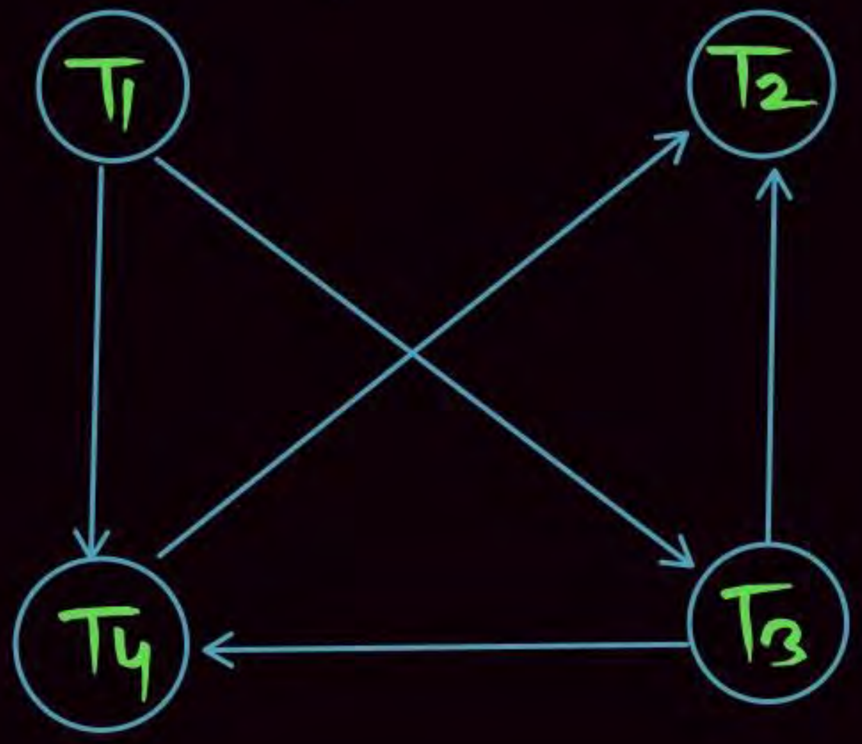
B $T_1 \rightarrow T_4 \rightarrow T_3 \rightarrow T_2$

C $T_4 \rightarrow T_1 \rightarrow T_3 \rightarrow T_2$

D $T_3 \rightarrow T_1 \rightarrow T_4 \rightarrow T_2$

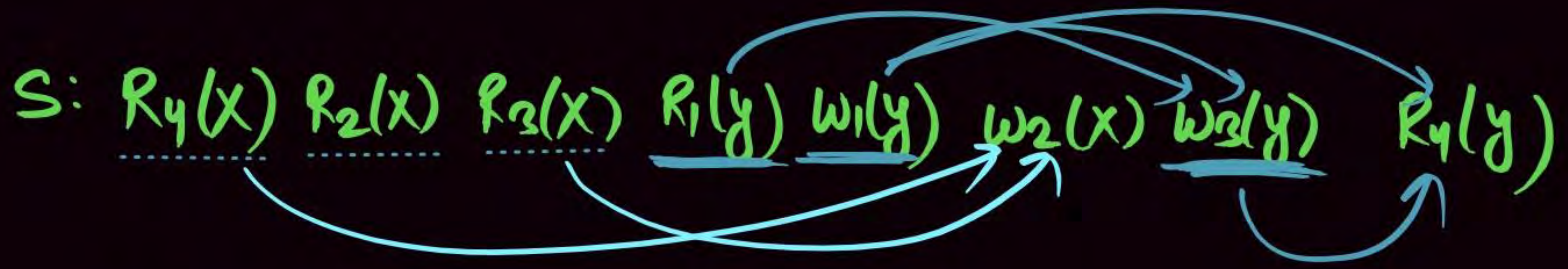
S: $R_4(X)\ R_2(X)\ R_3(X)\ R_1(y)\ W_1(y)\ W_2(X)\ W_3(y)\ R_4(y)$

T_1	T_2	T_3	T_4
			✓ R(X)
	✓ R(X)		
		✓ R(X)	
✓ R(y)			
✓ W(y)			
	✓ W(X)		
		W(y)	
			R(y)



$\langle T_1, T_3, T_4, T_2 \rangle$

Conflict operation Pair.



S: $R_4(X)\ R_2(X)\ R_3(X)\ R_1(y)\ W_1(y)\ W_2(X)\ W_3(y)\ R_4(y)$

DATA ITEM (X)

$R_4(X) - W_2(X)$: $T_4 \rightarrow T_2$ ✓

$R_3(X) - W_2(X)$: $T_3 \rightarrow T_2$ ✓

DATA Item (y)

$R_1(y) - W_3(y)$: $T_1 \rightarrow T_3$ ✓

$W_1(y) - W_3(y)$: $T_1 \rightarrow T_3$ ✓

$W_1(y) - R_4(y)$: $T_1 \rightarrow T_4$ ✓

$W_3(y) - R_4(y)$: $T_3 \rightarrow T_4$ ✓

$T_4 \rightarrow T_2$

$T_3 \rightarrow T_2$

$T_3 \rightarrow T_4$

$T_1 \rightarrow T_3 \rightarrow T_4 \rightarrow T_2$

Q.6

Consider the following transaction involving two bank accounts x and y.

read(x); x: = x – 50; write (x); read (y); y: = y + 50; write (y)

The constraint that the sum of the accounts x and y should remain constant is that of [2015(Set-2): 1 Marks]

A Atomicity

[✓ B] Consistency

C Isolation

D Durability

MCQ Q.7

Which one of the following is NOT a part of the ACID properties of database transactions?

[GATE-2016-CS: 1M]

(A) Atomicity

(B) Consistency

(C) Isolation

[✓ (D) Deadlock-freedom]

Topological Sorting.

Serializability Order

If Schedule is Conflict Serializable [Acylic Precedence Graph] then Serializablity order indicate (tells) that Non serial Schedule is equivalent to Which Serial Schedule.

Serializability Order

Topological Sorting

⇓

Process (Traverse)

(No Incoming edge)

Start from the vertex which having Indegree = 0.

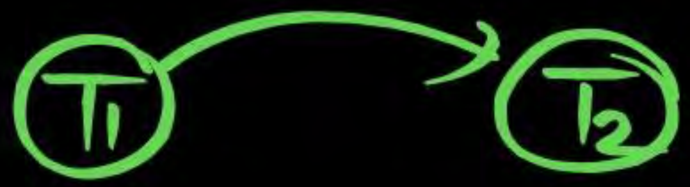
then Delete that vertex & all Connecting edge from that vertex

& Repeat this Process untill Complete Graph [all vertex] Traversed.

Serializability Order

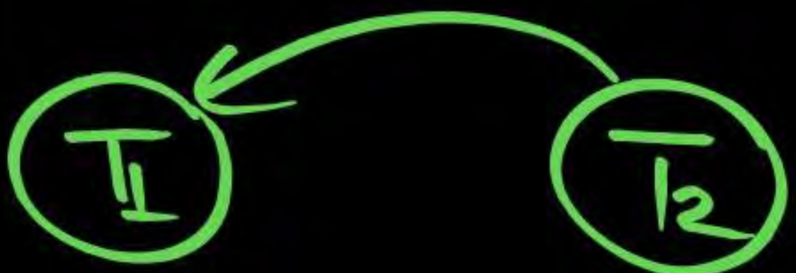
serializablity order

①



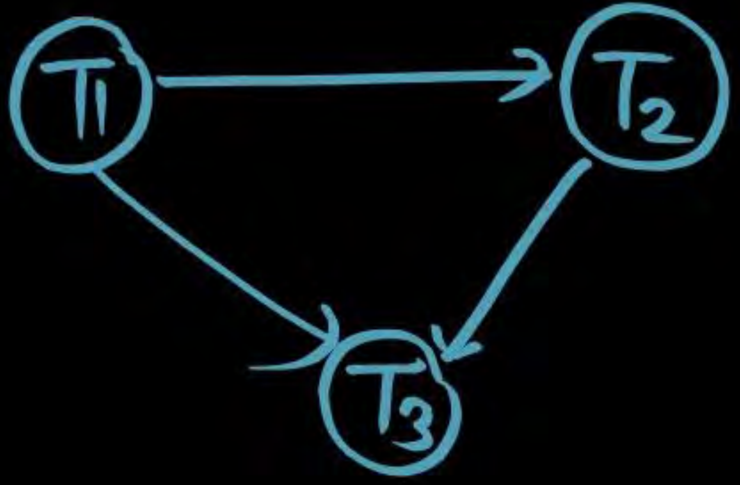
$\langle T_1, T_2 \rangle$

②



$\langle T_2, T_1 \rangle$ is equivalent to serial schedule T_2 followed by T_1

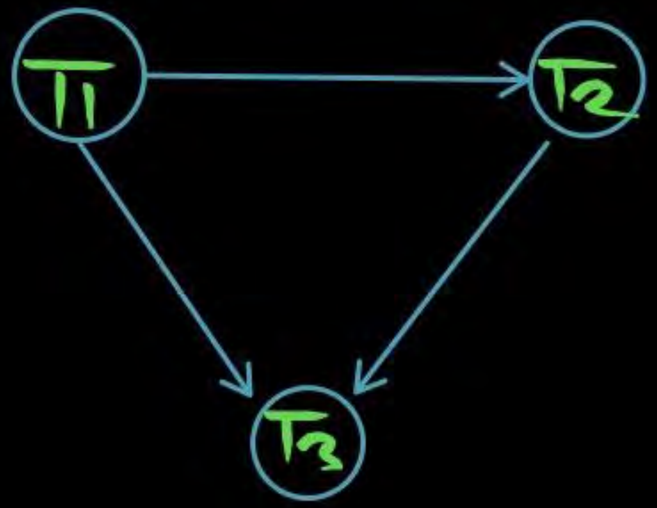
③



$\langle T_1, T_2, T_3 \rangle$

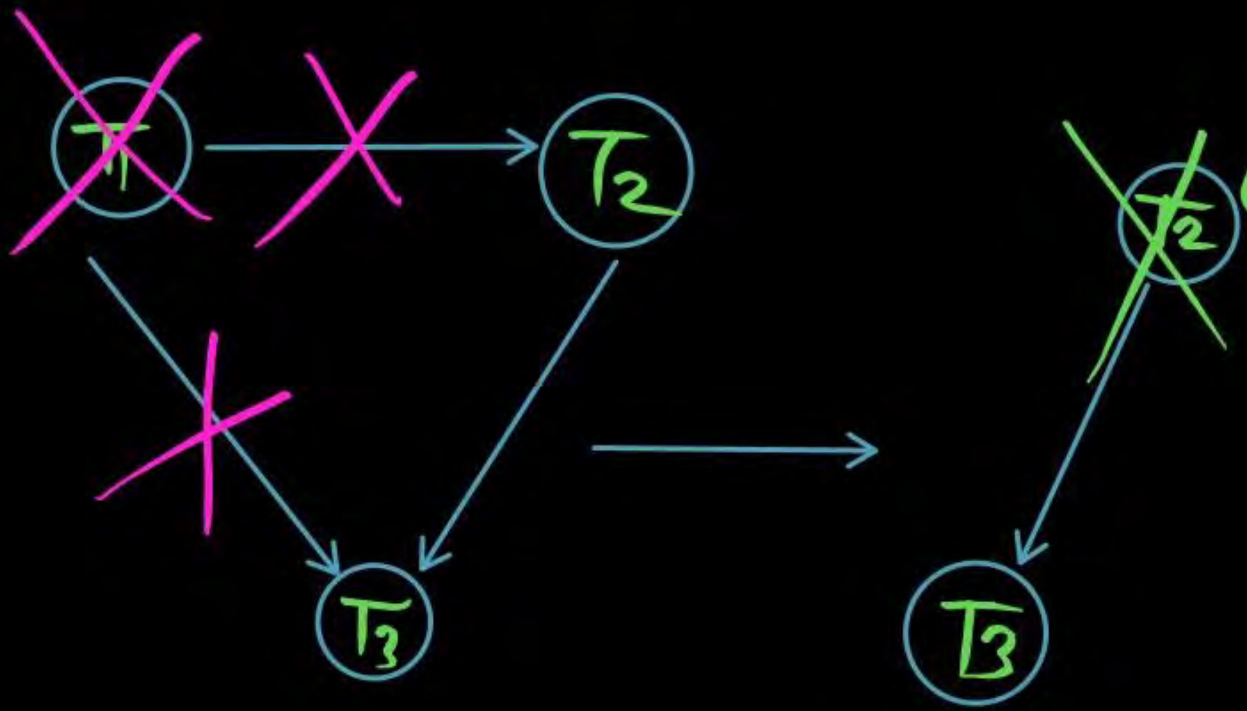
Serializability Order

③



Indegree = 0 (No Incoming edge).

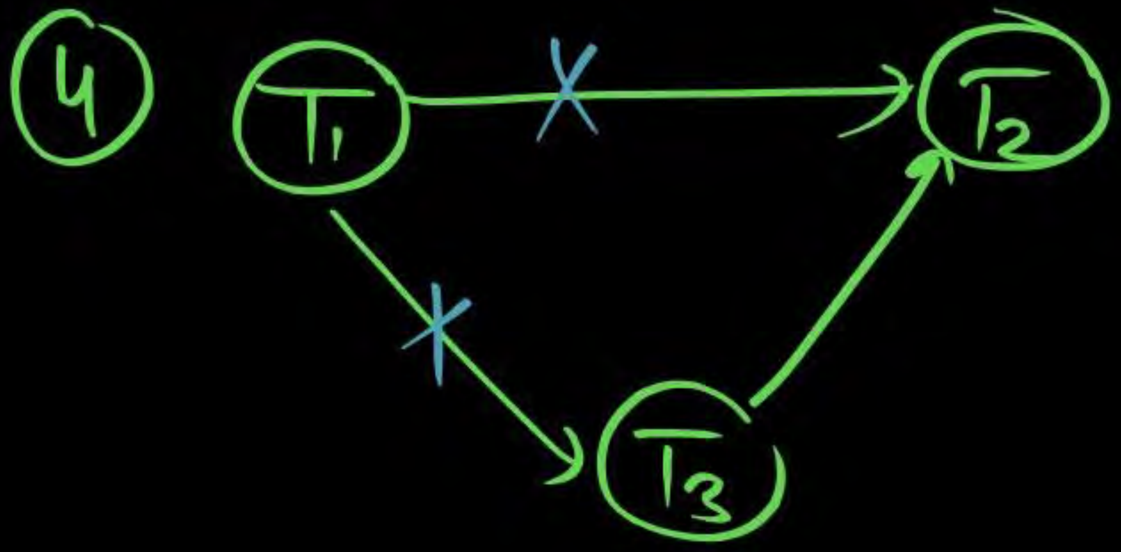
<T1,



(Indegree = 0 ⇒ T2)

<T1, T2, T3>.

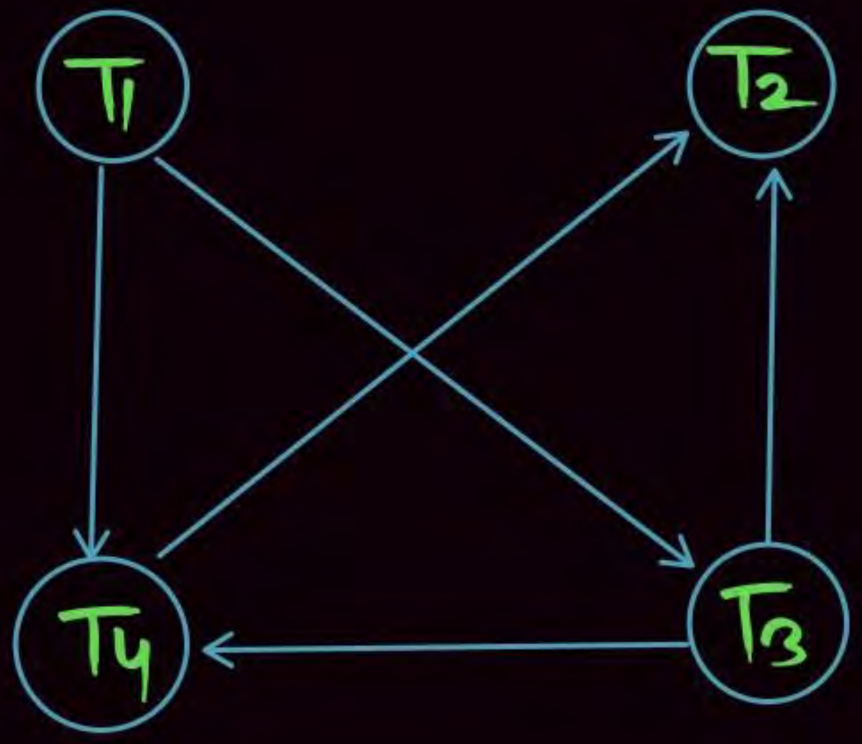
Serializability Order



< T1, T3, T2 >

Step1 Indegree $= 0 \Rightarrow T_1$

$\langle T_1,$

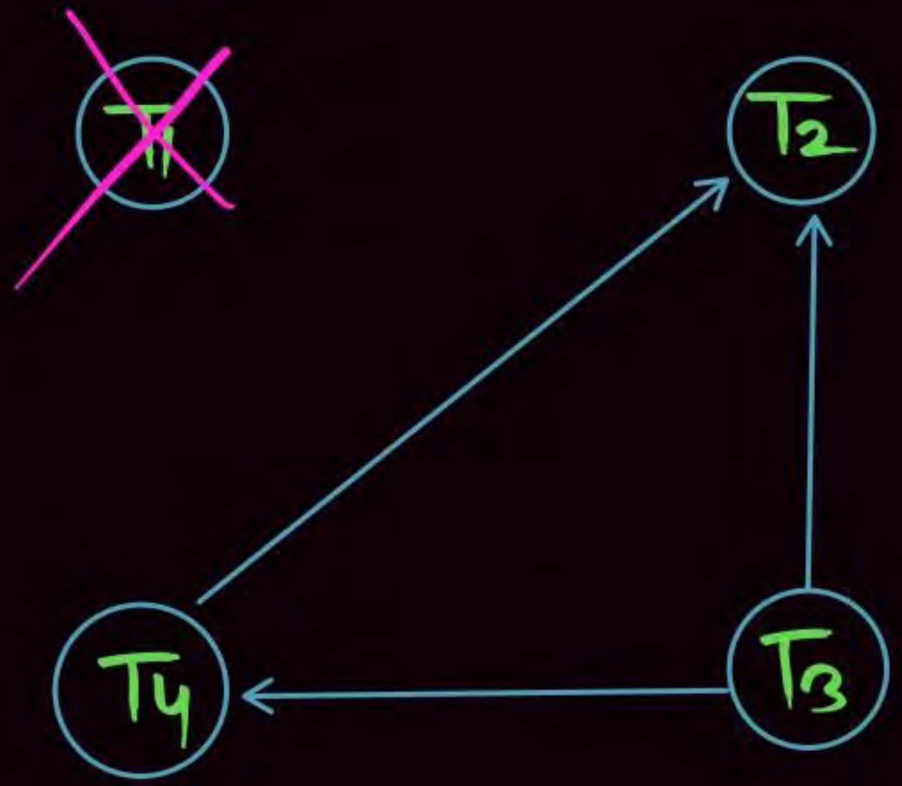


Step2 Indegree = 0 ∋ T_1

<T_1,

Now Indegree = 0 T_3

<T_1, T_3,



Step 3 Indegree = 0 ⇒ T_1

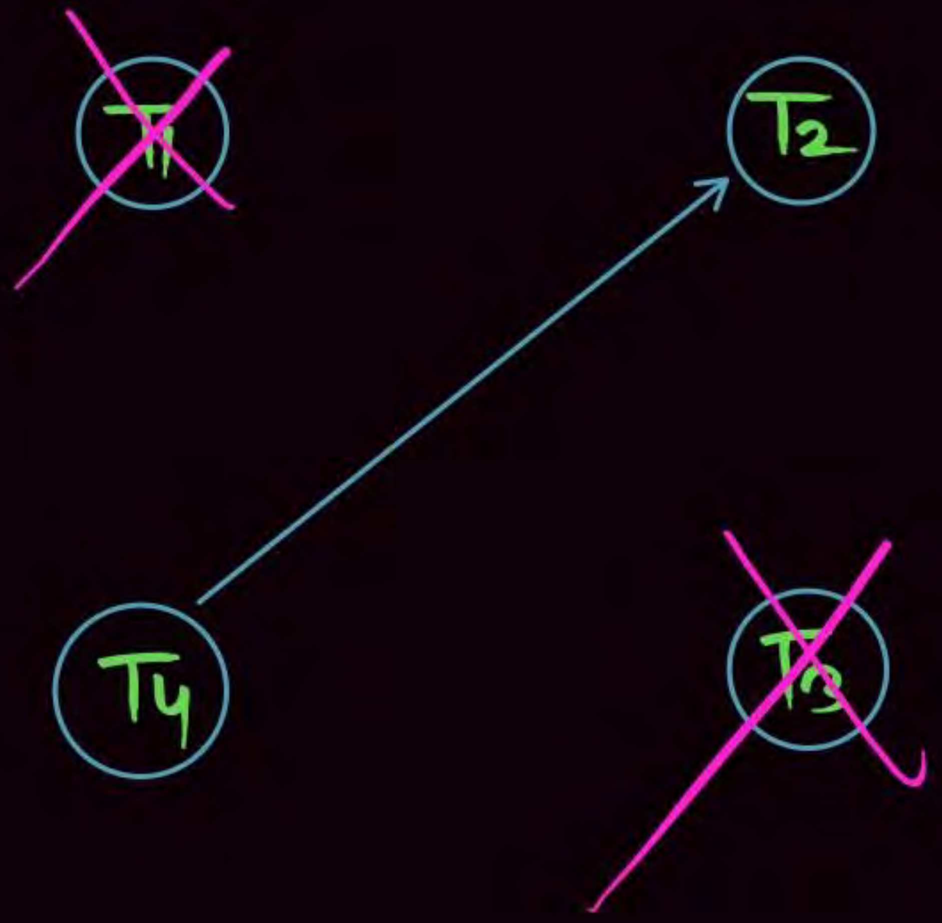
$< T_1,$

Now Indegree = 0 T_3

$< T_1, T_3,$

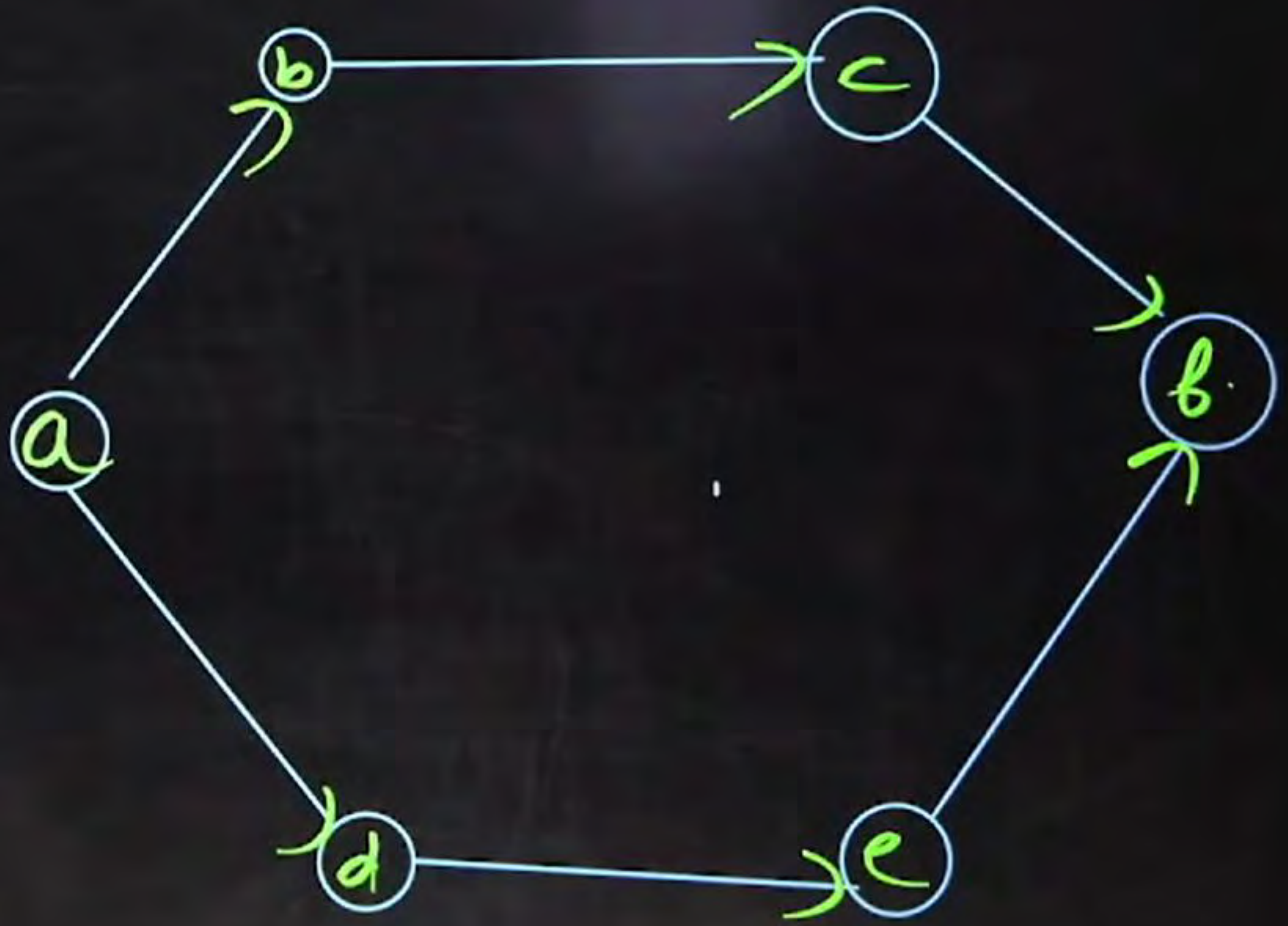
Now Indegree = 0 ⇒ T_4

$$\boxed{< T_1, T_3, T_4, T_2 >}$$ Ans



Serializability Order

HW



MCQ Q.8

Suppose a database schedule S involves transaction T_1......, T_n. Construct the precedence graph of S with vertices representing the transactions and edges representing the conflicts. If S is serializable, which one of the following orderings of the vertices of the precedence graph is guaranteed to yield a serial schedule?

[GATE-2016-CS: 2M]

(A ✓) T logical order

-first order

-first order

scending order of transaction indices

MCQ Q.9

Consider the following schedule for transactions T1, T2 and T3:

T1	T3	T3
Read(X)		
	Read (Y)	
		Read (Y)
	Write (Y)	
Write (X)		
		Write (X)
	Read (X)	
	Write (X)	

Which one of the schedules below is the correct serialization of the above?

[GATE-2010-CS: 2M]

(A) T 1 → T 3 → T 2

(B) T 2 → T 1 → T 3

(C) T2 → T3 → T1

(D) T3 → T 1 → T 2

MCQ Q.10

Consider two transactions T_1 and T_2, and four schedules S_1, S_2, S_3, S_4 of T_1 and T_2 as given below:

T_1: $R_1[x]$ $W_1[x]$ $W_1[y]$;
T_2: $R_2[x]$ $R_2[y]$ $W_2[y]$;

S_1: $R_1[x]$ $R_2[x]$ $R_2[y]$ $W_1[x]$ $W_1[y]$ $W_2[y]$;
S_2: $R_1[x]$ $R_2[x]$ $R_2[y]$ $W_1[x]$ $W_2[y]$ $W_1[y]$;
S_3: $R_1[x]$ $W_1[x]$ $R_2[x]$ $W_1[y]$ $R_2[y]$ $W_2[y]$;
S_4: $R_2[x]$ $R_2[y]$ $R_1[x]$ $W_1[x]$ $W_1[y]$ $W_2[y]$;

Which of the above schedules are conflict serializable?

[GATE-2009-CS: 2M]

(A) S_1 and S_2

[✓ (B) S_2 and S_3]

(C) S_3 only

(D) S_4 only

09:37

Conflict Equivalance.

111 + GATE PYQ

Conflict Equivalent Schedule

Two schedule are said to be conflict equivalent, if all conflicting operations in both the schedules must be executed in the same order.

Q.

S_1: $R_1(x)$ $W_1(x)$ $R_2(y)$ $W_2(y)$ $R_1(y)$

S_2: $R_1(x)$ $W_1(x)$ $R_1(y)$ $R_2(y)$ $W_2(y)$

T1	T2
R(x)	
W(x)	
	R(y)
	W(y)
R(y)	

Conflict operation

T1	T2
R(x)	
W(x)	
R(y)	
	R(y)
	W(y)

Q. S_1: $R_1(A)\ W_1(A)\ R_2(A)\ W_2(A)\ R_1(B)\ W_1(B)$

S_2: $R_1(A)\ W_1(A)\ R_2(A)\ R_1(B)\ W_2\ (A)\ W_1(B)$

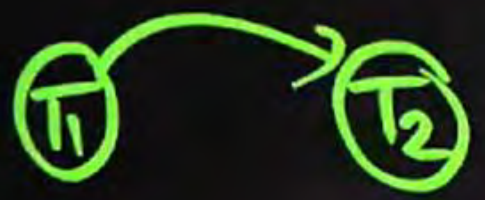
S_1

T_1	T_2
R(A)	
W(A)	
	R(A)
	W(A)
R(B)	
W(B)	

R(A) - W(A) : $T_1 \to T_2$
W(A) - R(A) : $T_1 \to T_2$
W(A) - W(A) : $T_1 \to T_2$

OR

$R_1(A) - W_2(A)$: $T_1 \to T_2$
$W_1(A) - R_2(A)$: $T_1 \to T_2$
$W_1(A) - W_2(A)$: $T_1 \to T_2$

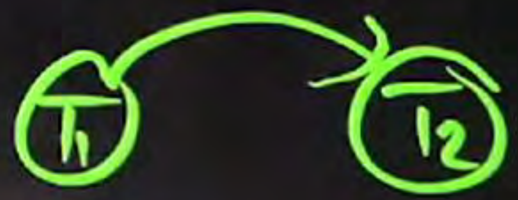


T_1	T_2
R(A)	
W(A)	
	R(A)
R(B)	
	W(A)
W(B)	

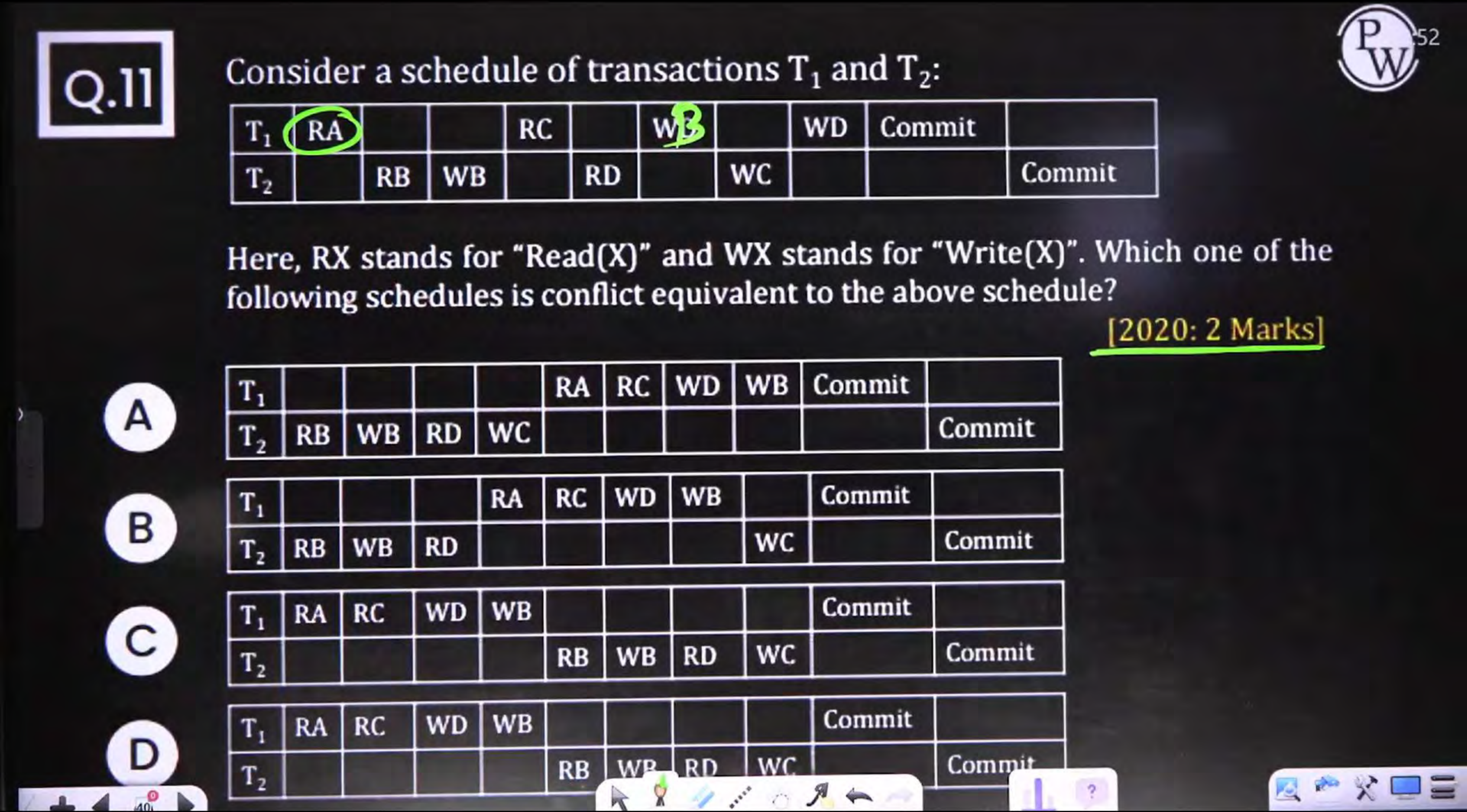
R(A) - W(A) : $T_1 \to T_2$
W(A) - R(A) : $T_1 \to T_2$
W(A) - W(A) : $T_1 \to T_2$

OR

$R_1(A) - W_2(A)$: $T_1 \to T_2$
$W_1(A) - R_2(A)$: $T_1 \to T_2$
$W_1(A) - W_2(A)$: $T_1 \to T_2$



S_1 is Conflict Equivalent to S_2



Q.11

Consider a schedule of transactions T_1 and T_2:

T_1	RA			RC		WB		WD	Commit	
T_2		RB	WB		RD		WC			Commit

Here, RX stands for "Read(X)" and WX stands for "Write(X)". Which one of the following schedules is conflict equivalent to the above schedule?

[2020: 2 Marks]

A

T_1					RA	RC	WD	WB	Commit	
T_2	RB	WB	RD	WC						Commit

B

T_1				RA	RC	WD	WB		Commit	
T_2	RB	WB	RD					WC		Commit

C

T_1	RA	RC	WD	WB					Commit	
T_2					RB	WB	RD	WC		Commit

D

T_1	RA	RC	WD	WB					Commit	
T_2					RB	WB	RD	WC		Commit

Conflict Serializable.

① BASIC Concept [Swapping of Non Conflict Instruction)

② Testing [Precedence Graph Method] ⇒ CNC

[redacted]

Conflict Serializable

A schedule is said to be conflict serializable if it is conflict equivalent to a serial schedule.

Same conflicting operation order in C_1 & S_1

$\therefore$ Its $\{C_1\}$ conflict is conflict serializable.

$R_1(A) - W_2(A)$
$W_1(A) - R_2(A)$
$W_1(A) - W_2(A)$

$r_1(B) - W_2(B)$
$W_1(B) - R_2(B)$
$W_1(B) - W_2(B)$

T_1	T_2
read(A)	
write(A)	
	read(A)
	write(A)
read(B)	
write(B)	
	read(B)
	write(B)

C_L

T_1	T_2
read(A)	
write(A)	
read(B)	
write(B)	
	read(A)
	write(A)
	read(B)
	write(B)

$r_1(A) - W_2(A)$
$W_1(A) - R_2(A)$
$W_1(A) - W_2(A)$
$r_1(B) - W_2(B)$
$W_1(B) - R_2(B)$
$W_1(B) - W_2(B)$

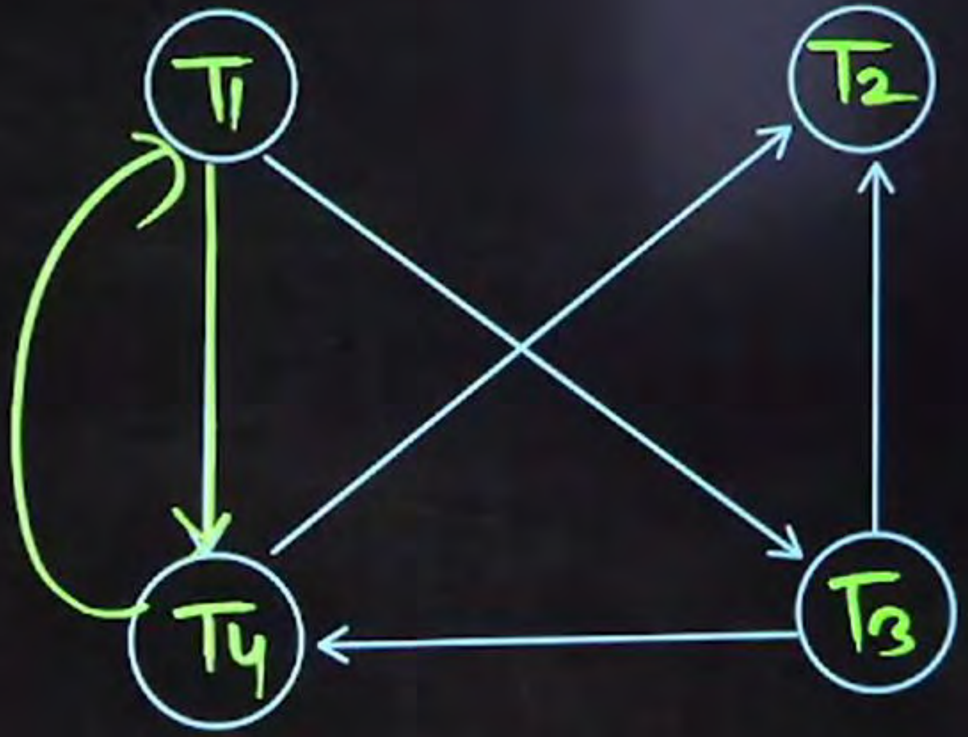
S_L

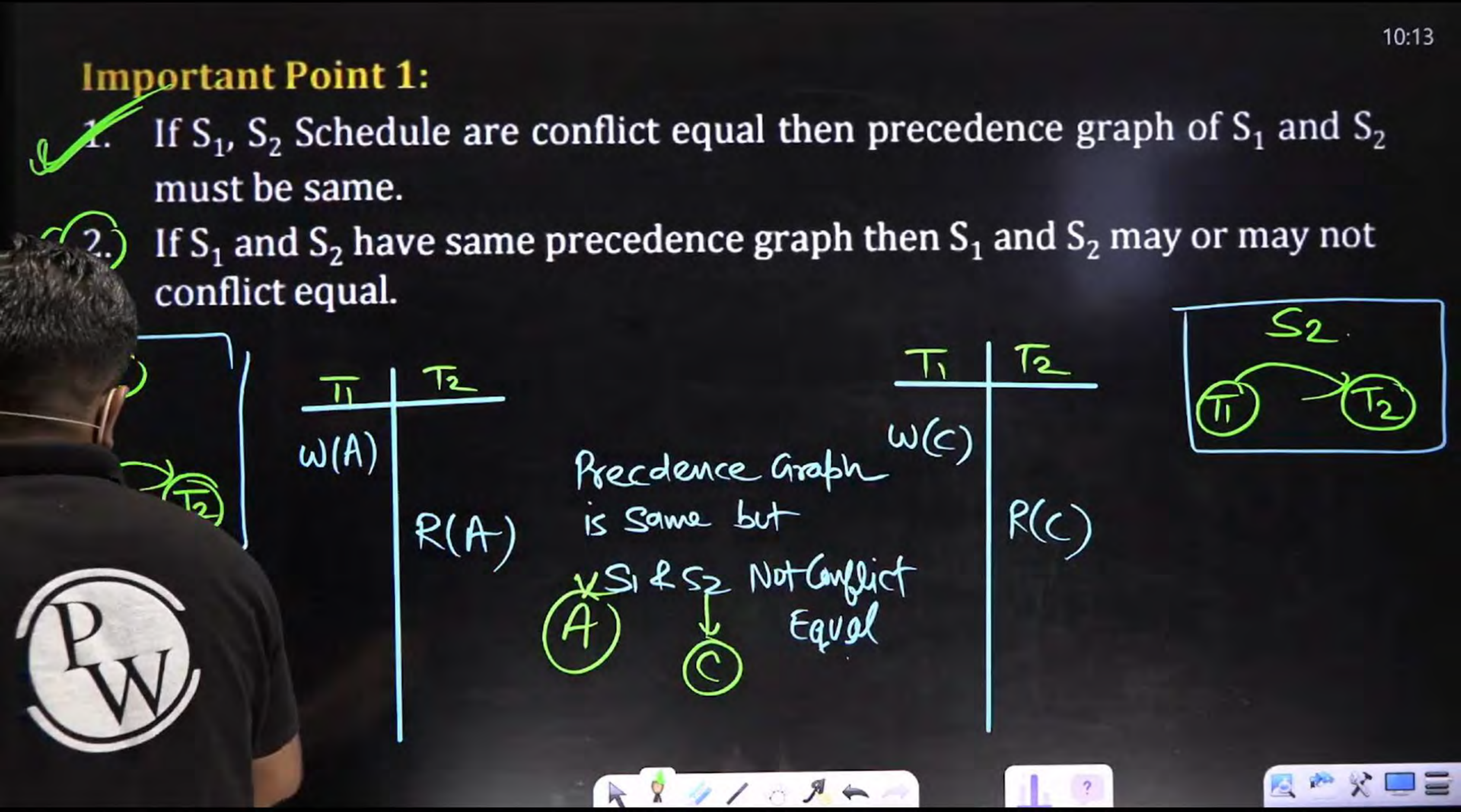
10:02

T_1 & T_4 form a cycle

CNC

Cycle Not Conflict





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Important Point 1:

1. If S_1, S_2 Schedule are conflict equal then precedence graph of S_1 and S_2 must be same.
2. If S_1 and S_2 have same precedence graph then S_1 and S_2 may or may not conflict equal.

T_1	T_2
W(A)	
	R(A)

Precedence Graph is same but S_1 & S_2 Not Conflict Equal

A

C

T_1	T_2
W(C)	
	R(C)

S_2

Q. 1

S_1: $R_1(A)\ W_1(A)\ R_2(A)\ W_2(A)\ R_1(B)\ W_1(B)$

S_2: $R_1(A)\ W_1(A)\ R_2(A)\ R_1(B)\ W_2\ (A)\ W_1(B)$

S_1

T_1	T_2
R(A)	
W(A)	
	R(A)
	W(A)
R(B)	
W(B)	

R(A) - W(A) : $T_1 \rightarrow T_2$

W(A) - R(A) : $T_1 \rightarrow T_2$

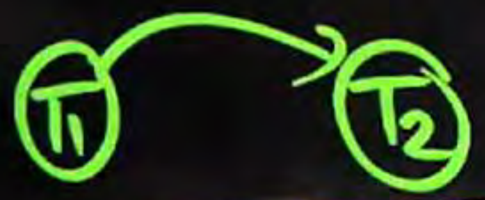
W(A) - W(A) : $T_1 \rightarrow T_2$

OR

$R_1(A) - W_2(A)$: $T_1 \rightarrow T_2$

$W_1(A) - R_2(A)$: $T_1 \rightarrow T_2$

$W_1(A) - W_2(A)$: $T_1 \rightarrow T_2$



S_1 is Conflict Equivalent to S_2

T_1	T_2
R(A)	
W(A)	
	R(A)
R(B)	
	W(A)
W(B)	

R(A) - W(A) : $T_1 \rightarrow T_2$

W(A) - R(A) : $T_1 \rightarrow T_2$

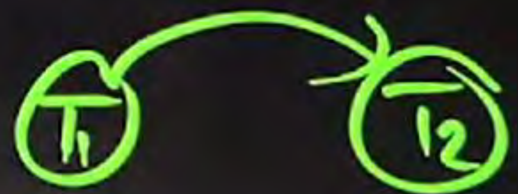
W(A) - W(A) : $T_1 \rightarrow T_2$

OR

$R_1(A) - W_2(A)$: $T_1 \rightarrow T_2$

$W_1(A) - R_2(A)$: $T_1 \rightarrow T_2$

$W_1(A) - W_2(A)$: $T_1 \rightarrow T_2$



serializable

A Schedule is Serializable if either it is Conflict Serializable or View Serializable or Both.

Note If Schedule is Conflict Serializable (Acylic Graph) then already it is View Serializable.

Note If Schedule is Not Conflict Serializable [CNC] then it May or

10:25

(Not Conflict But)

- If Schedule is View Serializable then Schedule is Serializable [Consistent]

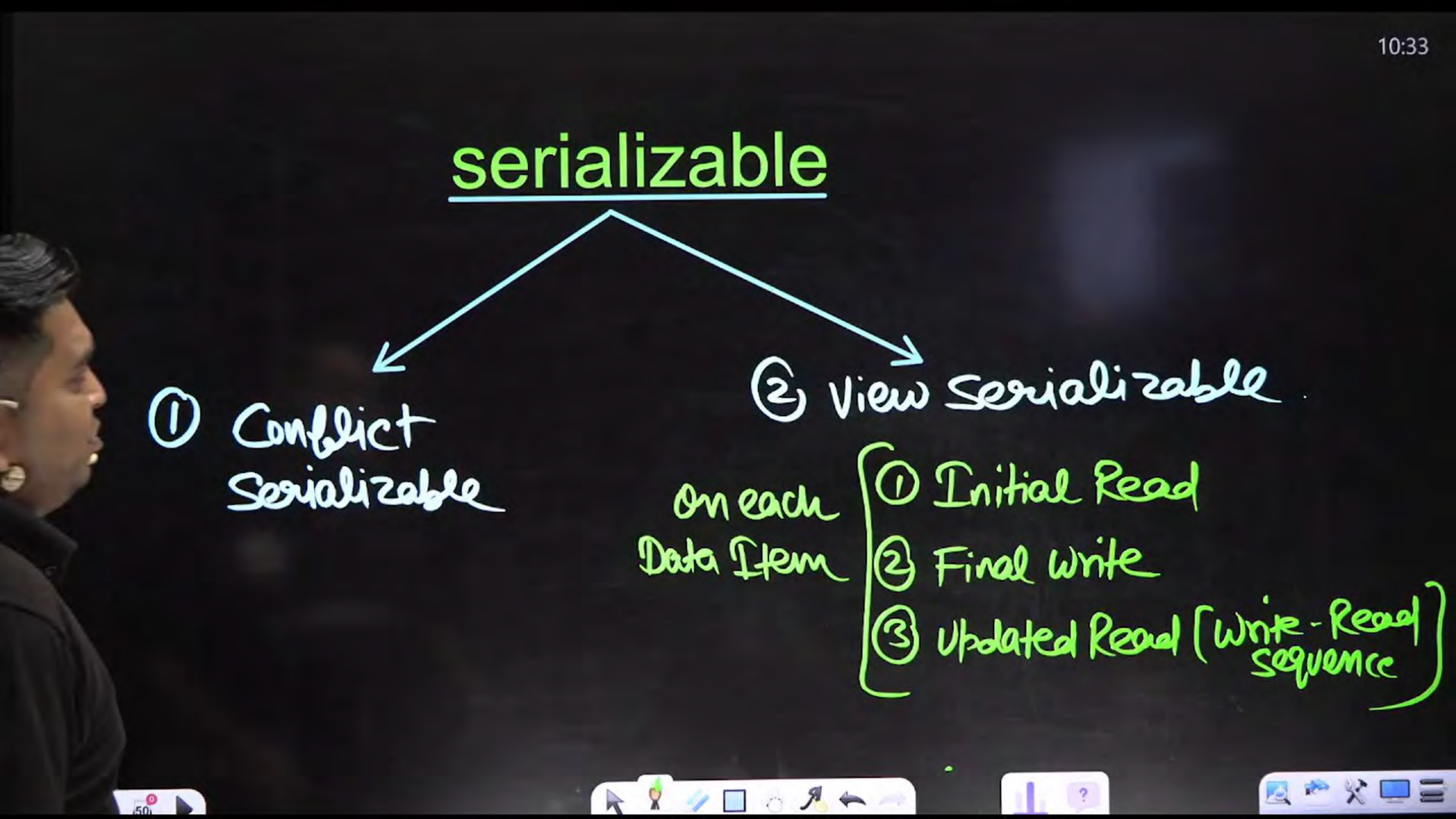
Schedule is Not Conflict & Not View then Schedule s Non Serializable Schedule [In Consistent]

f Conflict ✓
n already
View SatisFy ✓

if Not Conflict Serializable [CNC]

View SatisFy
⇓
Serializable

View Fail (Not SatisFy)
⇓
Not Serializable.



serializable

① Conflict Serializable

② View serializable

On each Data Item

① Initial Read

② Final write

③ Updated Read (Write-Read sequence)

THANK YOU!