COMPUTER SCIENCE

Database Management System

Transaction & Concurrency Control



Lecture_5

Vijay Agarwal sir





Serializable Schedule

Conflict & View Serializable





Serial Schedule

ALWAYS
Consistent

Non Serial Schedule.

May or May Not

be consisent



Serializable Schedule.

O Conflict Servalizable 2 View Serializable



Conflict Serializable

Conflict Instruction

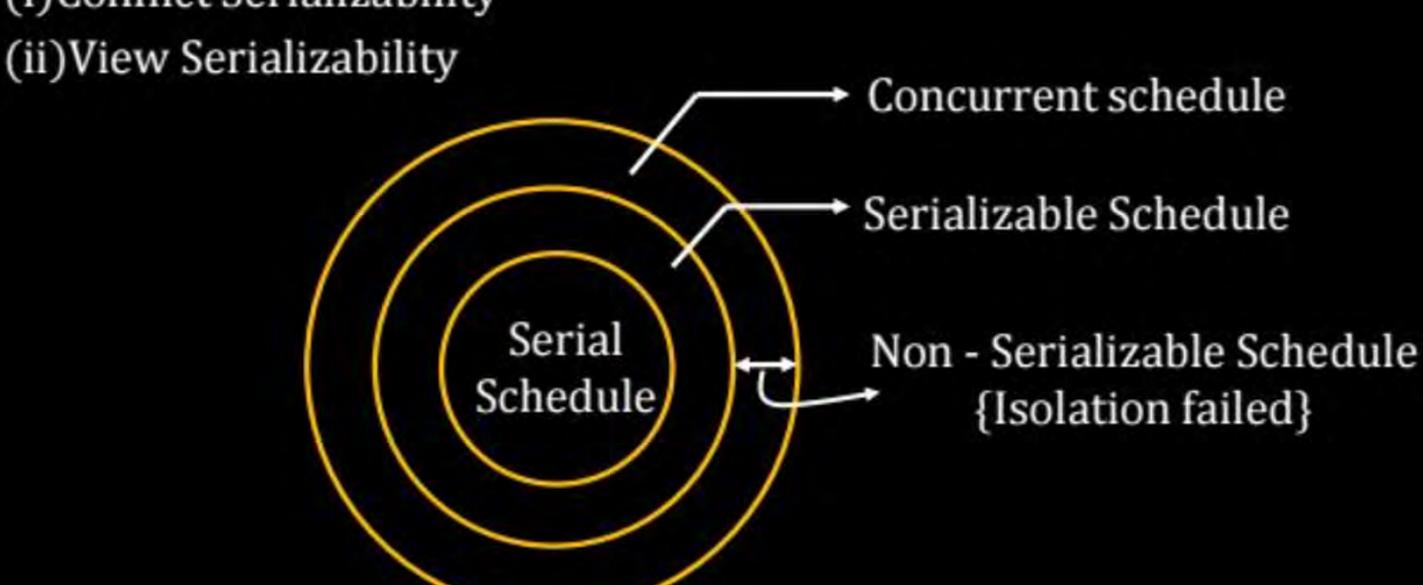
Same Date Item

Ti Ti RIA) WIA) Conflict WIA) RIA) Tryth WIA) WIA) Fryth

Serializable Schedule

A Schedule is serializable Schedule if it is equivalent to a Serial Schedule.

(i) Conflict Serializability



Conflict Servalizable

- (1) BASIC Concept
- 1 Testing for Conflict Servializablity
 La Precidence Grouph Method
- 3 Conflict Boils. Conflict Equivalent to Any Serval Schedule.

Conflict Serializability



- If a schedule S can be transformed into a schedule S' by a series of swaps of non-conflicting instructions, we say that S and S' are conflict equivalent.
- We say that a schedule S is conflict serializable if it is conflict equivalent to a serial schedule.

Conflict Serializability (Cont.)



Schedule 3 can be transformed into Schedule 6, a serial schedule where T₂ follows T₁, by series of swaps of non-conflicting instructions. Therefore Schedule 3 is conflict serializable.

Schedule 3

T ₁	T ₂	
read (A)		
Write (A)		
	read (A)	
	write (A)	
read (B)		
write (B)		
	read (B)	
	write (B)	

Schedule 6

T ₁	T ₂
read (A) write (A) read (B) write (B)	read (A) write (A) read (B) write (B)

Conflict Serializability (Cont.)



Example of a schedule that is not conflict serializable:

T ₃	T ₄
read (Q)	
	write (Q)
write (Q)	

We are unable to swap instructions in the above schedule to obtain either the serial schedule < T3, T4 >, or the serial schedule < T4, T3 >

Conflict Serializable



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

Same conflicting operation order in C₁ & S₁

∴ Its {C₁} conflict is conflict serializable.

T ₁	T ₂	T ₁	T ₂
read(A) write(A)	read(A) write(A)	read(A) write(A) read(B) write(B)	
read(B) write(B)	read(B) write(B)		read(A) write(A) read(B) write(B)
CL			S _L

Conflicting Instructions



- Instructions l_i, and l_j of transactions T_i and T_j respectively, conflict if and only if there exists some item Q accessed by both l_i, and l_j, and at least one of these instructions wrote Q.
 - 1. l_i , = read(Q)) l_i = read(Q). l_i and l_i don't conflict.
 - 2. l_i = read(Q) l_i = write(Q). They conflict.
 - 3. l_i , = write(Q) l_i = read(Q). They conflict
 - 4. $l_i = write(Q) l_i = write(Q)$. They conflict
- Intuitively, a conflict between l_i and l_j forces a (logical) temporal order between them.
 - If l_i, and l_j are consecutive in a schedule and they do not conflict, their results would remain the same even if they had been interchanged in the schedule.

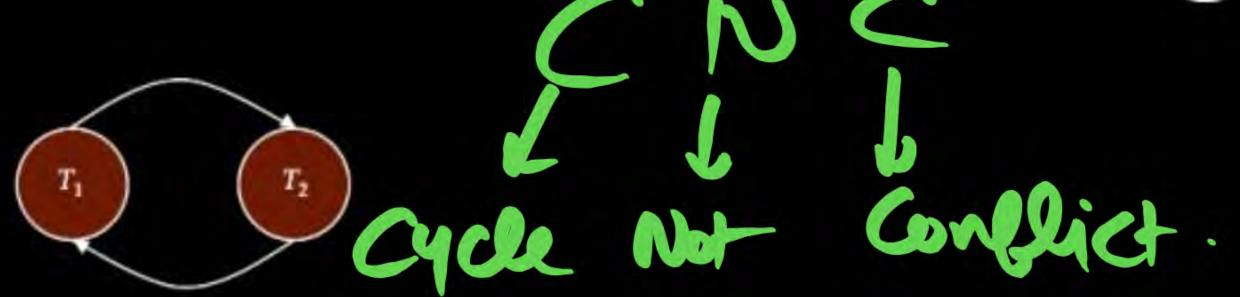
Testing for Serializability



- Testing for conflict serializability.
 - Consider some schedule of a set of transactions T₁, T₂, ...T_n
 - Precedence graph a direct graph where the vertices are the transactions (names).
 - We draw an arc from T_i to T_j if the two transaction conflict, and T_i accessed the data item on which the conflict arose earlier.
 - We may label the arc by the item that was accessed.



Example:



A schedule is conflict serializable if and only if its precedence graph is acyclic.

NOTE: CNC [Cycle not conflict serializable]





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]

- 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.



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.
- S_1 is not conflict serializable, and S_2 is conflict serializable.
 - C Both S_1 and S_2 are conflict serializable.
 - D Neither S₁ nor S₂ is conflict serializable.



CNC > Cycle Not Conflict

The Graph Contain Cycle [Any one Cycle) then

Not Conflict Serializable.

If Graph is Acyclic [Not Contain My cycle] then schedule is Conflict Servalizable.

Topological Sorting

Serializability Order (Acyclic from)

16 Schadule is Serial rable (Conflict a View Serial rable) than Serializablic order tells (indicate) this Non Serial Schedule

is equivalent to which Serial schedule.

Topological Sorting: Determines the Servializability order.

..



Topological Softing.

Stepl: Steet from the vertex which having

Indegree = D' [No In Coming edge]

Stepz: Delete that vortex & Converbonding edge

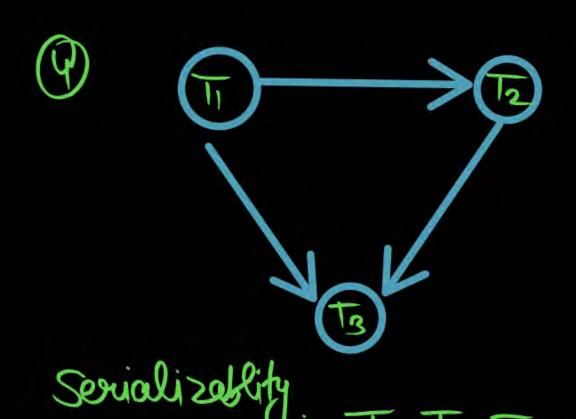
& So On (Repeat this Pource)



Serializablity order

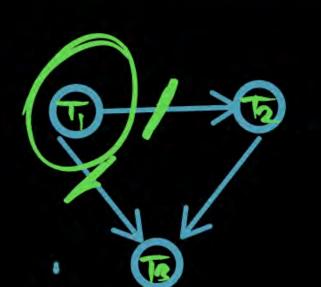






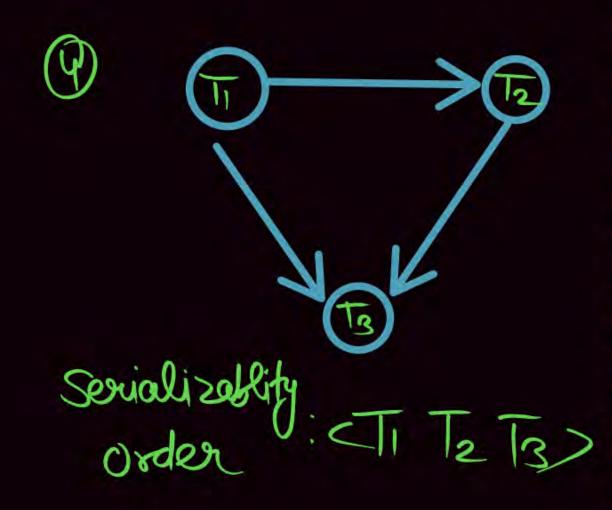
Order

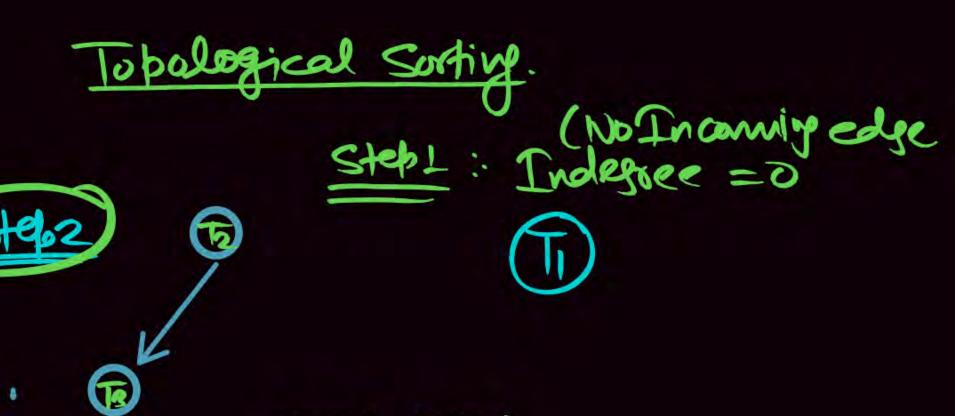
Topalogical Sorting.



Step 1: Indegree = 0

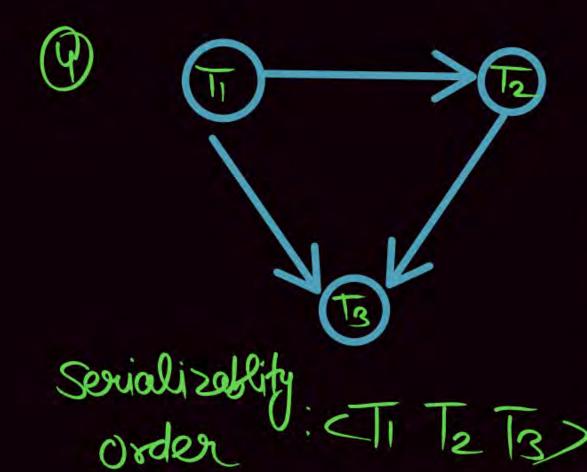






Next Step.
To indegree = 0

CTITE



Topological Sorting.

Step 1: Indegree = 0

next Step.

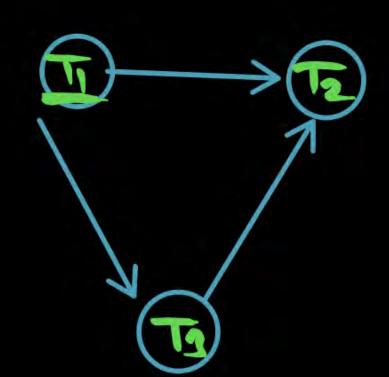
B

To indegree = 0

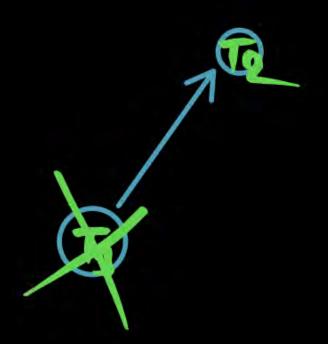
CT, T2, T3)















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]



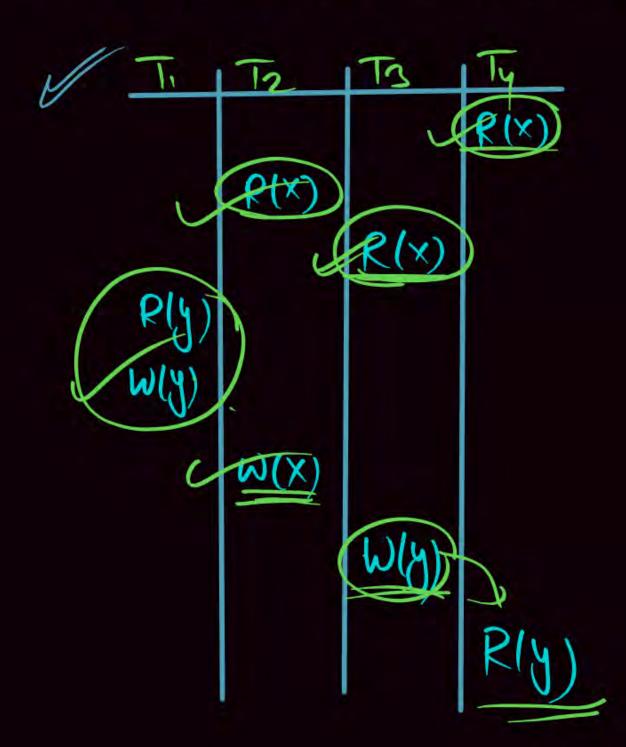
$$T_1 \rightarrow T_3 \rightarrow T_4 \rightarrow T_2$$

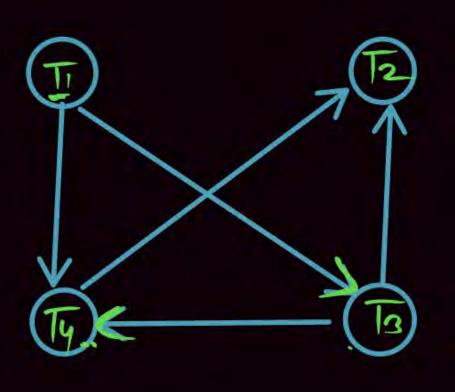
$$B \qquad T_1 \to T_4 \to T_3 \to T_2$$

$$C \qquad T_4 \to T_1 \to T_3 \to T_2$$

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

S: Ry(X) R2(X) R3(X) R1(y) W1(y) W2(X) W3(y) Ryly)





CTI, T3, T4, T2>

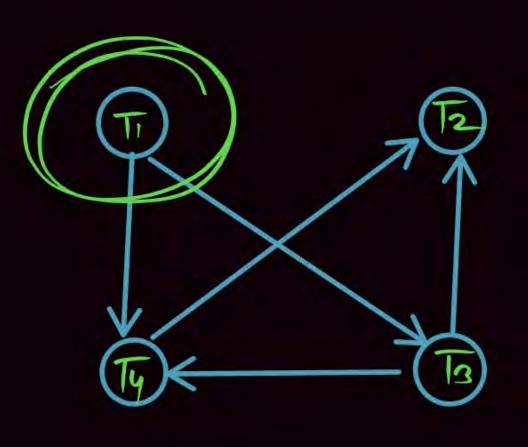
S: Ry(X) Rz(X) R3(X) R1(y) W1(y) W2(X) W3(y) Ry(y)

Topological Socting

Indepose = 0

TI

Step2) Delete that vertex & corresponding edge



Part I

S: Ry(x) R2(x) R3(x) R1(y) w1(y) w2(x) w3(y) Ry(y)

Topological Socting.

Stepl

Indegree = 0

TI

Sepr

DONE

Indepose = 0 (T3) Part II)
then Delete that vortex & Groesponding edge

2.50

S: Ry(X) Rz(X) R3(X) R1(y) W1(y) W2(X) W3(y) Ry(y) CT1, T2, Topological Socting. Stepl Indepree = 0 (Sep2) Done. (Ty) Indeposee = 0 (T3) & Delete: (Past III

S: Ry(X) R2(X) R3(X) R1(y) W1(y) W2(X) W3(y) Ry(y) CT1, T2, T4, T2) Topological Socting. Stepl Indepree = 0 (Sep2) Done. Indeposee = 0 (T3) & Delete.

Indepree = 0 (Ty) then Delete.

Alternate Abbrach.

Part I

$$R_4(x) - \omega_2(x)$$

$$R_3(x) - \omega_2(x)$$

$$\omega_1(y) - \omega_2(y)$$

Order

$$R_{4}(x) - \omega_{2}(x)$$

$$R_3(x) - \omega_2(x)$$

$$1-\omega_2(x)$$
 T3

$$R_1(y) - \omega_2(y)$$

$$\omega_{1}(y) - \omega_{3}(y)$$



Consider the following transaction involving two bank accounts



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

x and y.

- Consistency
 - C Isolation
 - D Durability





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

Deadlock-freedom

D: Durablity.





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 Topological order
- B Depth-first order
- C Breadth-first order
- D Ascending order of transaction indices

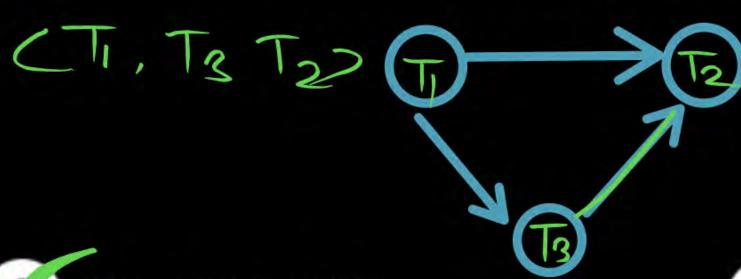


Pw

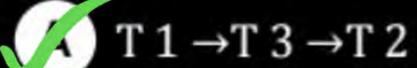
Consider the following schedule for transactions T1, T2 and T3:

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

[GATE-2010-CS: 2M]



	T1	TS	Т3
L	Read(X)		
	U	Read (Y)	
			Read (Y)
		Write (Y)	
L	Write (X)		
			Write (X)
		Read (X)	
		Write (X)	



C
$$T2 \rightarrow T3 \rightarrow T1$$

B T 2
$$\rightarrow$$
 T 1 \rightarrow T 3

D T3
$$\rightarrow$$
T1 \rightarrow T2





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



C S_3 only



(1) BASIC CONCEPT

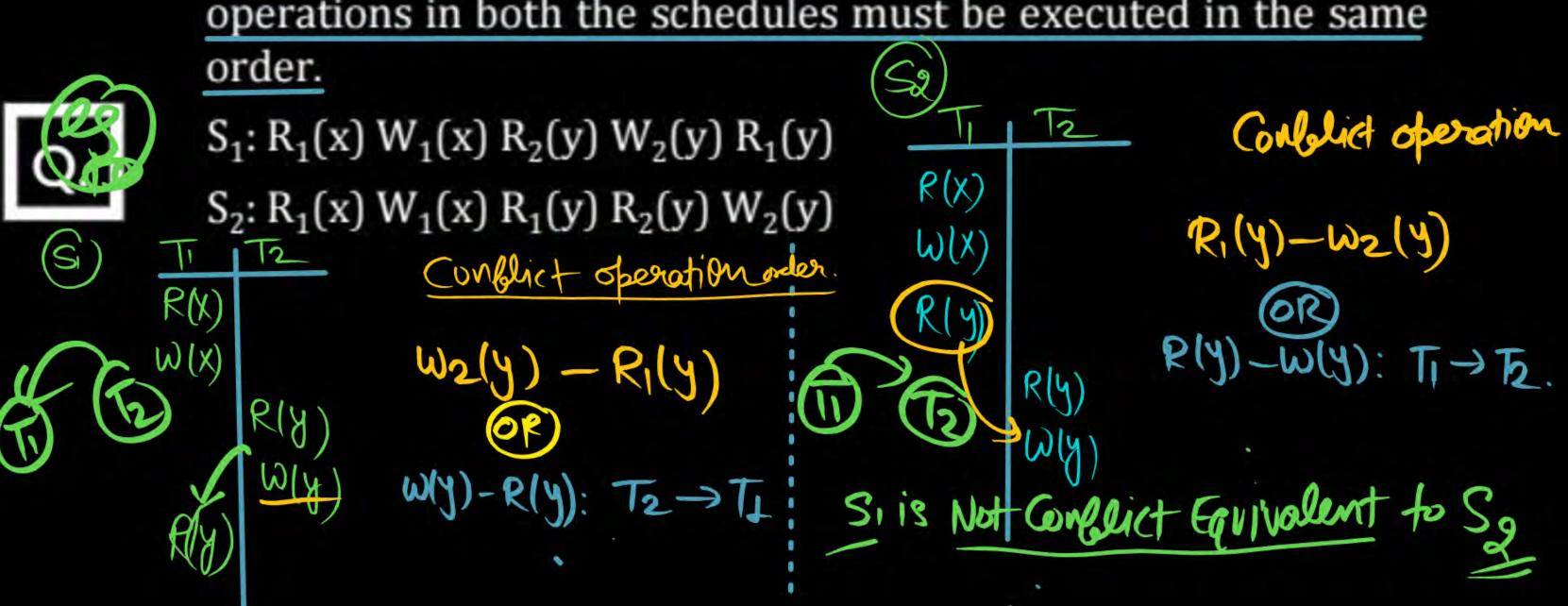
Testing Method Precdence Graph.

(9) Conflict Equivalent Schedule.

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



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

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

R(A) W(A)

Conflict operation!



 $R_1(A) - \omega_2(A)$

W1(A) - R2(A)

R(B)

3) WI(A) - W2(A)



R(A)-W(A): TI-> T2

W(A) - R(A): TI -> T2

WIA)-WIAI: T-> tz



W(B)

Conflict obceation

R, (A) - W2(A)

WILA) - W2/A)

3) WI(A) - P2(A)

R(B)



R/A)-WLA): TI -> T2

W/A)-R(A): TI-> T2

W/11-W/1): TI-> T2.

S, is consult equivant to So

WIB

 $S_1: R_1(A) W_1(A) R_2(A) W_2(A) R_1(B) W_1(B) R_2(B) W_1(B)$ Qa $S_2: R_1(A) W_1(A) R_2(A) R_1(B) W_2(A) W_1(B) R_2(B) W_1(B)$ 12 RIA WIA) W(A) R(A) R(A) W(A) R(B) T2 R(B) WLB Cycle (CNK

Not Confiliti

W(B)

Rota are Conflict

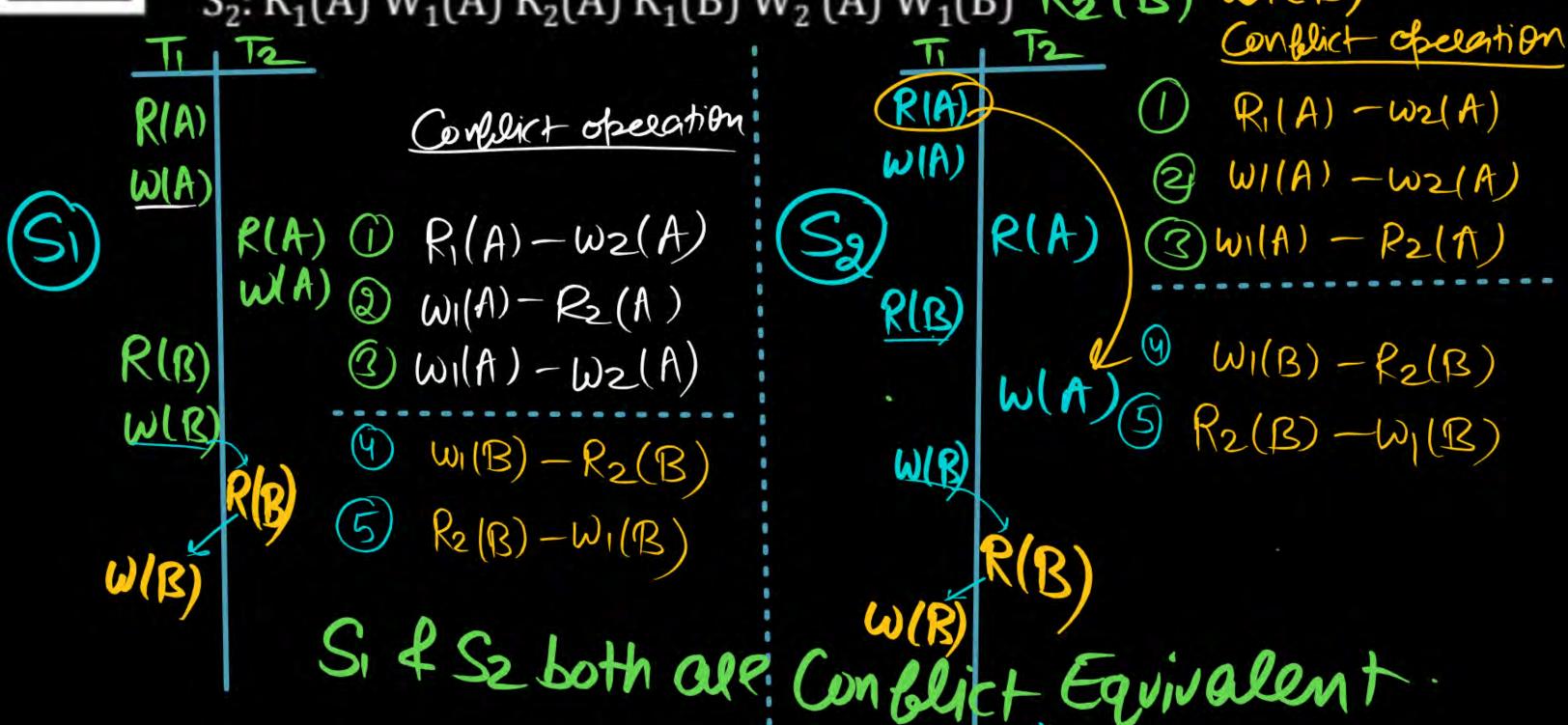
W(B)

Qa

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



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





Consider a schedule of transactions T₁ and T₂:



T ₁	RA		RC	WD	WB	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] Commit WB W2(C)-R(C) (T2→T) WB RD WC Commit RC_WD-WB Commit RA RD WC Commit Commit RA RC WB WB RD T_2 RB WC Commit RA RC WD WB Commit RB WB RD WC Commit

$$R(B) - \omega(B) : T_2 \rightarrow T_1$$

OR) $\omega(B) - \omega(B) : T_2 \rightarrow T_1$

$$R(C) - \omega(C) : T_1 \rightarrow T_2$$

$$R(D) - \omega(D) : T_2 \rightarrow T_1$$





Consider the following three schedules of transactions T1, T2 and T3. [Notation: In the following NYO represents the action Y (R for read, W for write) performed by transaction N on object O.]

S1: 2RA 2WA 3RC 2WB 3WA 3WC 1RA 1RB 1WA 1WB

S2: 3RC 2RA 2WA 2WB 3WA 1RA 1RB 1WA 1WB 3WC

S3: 2RA 3RC 3WA 2WA 2WB 3WC 1RA 1RB 1WA 1WB

Which of the following statements is TRUE? [GATE-2008-CS: 2M]

- A S1, S2 and S3 are all conflict equivalent to each other
- B No two of S1, S2 and S3 are conflict equivalent to each other
- C S2 is conflict equivalent to S3, but not to S1
- S1 is conflict equivalent to S2, but not to S3

Conflict Serializable



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

	T ₁	T ₂	T ₁	T ₂
Same conflicting	read(A)		read(A)	
operation order in C ₁ &	write(A)		write(A)	
S_1		read(A)	read(B) write(B)	
:. Its {C ₁ } conflict is		write(A)	Wille(D)	wood(A)
conflict serializable.	read(B)			read(A) write(A)
Commet serializable.	write(B)			read(B)
A: 1710		read(B)		write(B)
1 8:3290 SICTITS)		write(B)		S.
5000		CL		

Important Point 1:

- 1. If S₁, S₂ Schedule are conflict equal then precedence graph of S₁ and S₂ must be same.
 - If S₁ and S₂ have same precedence graph then S₁ and S₂ may or may not conflict equal.

