**TRANSACTIONS AND CONCURRENCY CONTROL**

Questions and Solutions

1. Consider the following schedule:

$S_1$: $R_1(A)$; $R_1(C)$; $R_2(B)$; $W_2(B)$; $R_3(B)$; $R_1(A)$; $R_3(C)$; $W_3(C)$; $W_1(A)$

$S_2$: $R_2(A)$; $R_1$ (C); $R_2(B)$; $R_3(B)$; $W_2(B)$; $R_1(A)$; $R_3(C)$; $W_3(C)$; $W_1(A)$

Which of the above schedules is conflict serializable?

(a) $S_1$ only

(b) $S_2$ only

(c) Both $S_1$ and $S_2$ only

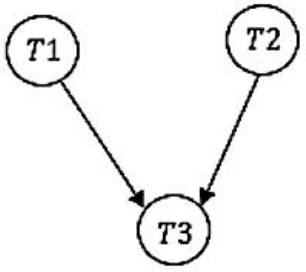
(d) Neither $S_1$ nor $S_2$

**Solution**: Option (a)

**Explanation**:

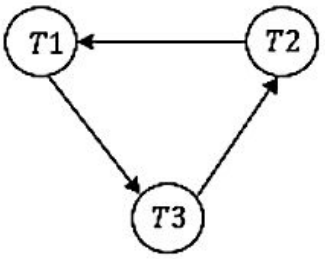
S1:

| T1 | T2 | T3 |
|---|---|---|
| r(A) | | |
| r(C) | | |
| | r(B) | |
| | w(B) | |
| | | R(B) |
| R(A) | | |
| | | R(C) |
| | | w(C) |
| w(A) | | |



$S2$:

| $T1$ | $T2$ | $T3$ |
|---|---|---|
| | $r(A)$ | |
| $r(C)$ | | |
| | $r(B)$ | |
| | | $r(B)$ |
| | $w(B)$ | |
| $r(A)$ | | |
| | | $r(C)$ |
| | | $w(C)$ |
| $w(A)$ | | |




In the above precedence graph cycle is present. Therefore, $S_2$ is not conflict serializable.

2. Consider the following schedule:

S: $r_2(A)$, $r_1(B)$, $w_2(A)$, $r_2(B)$, $r_3(A)$, $w_1(B)$, $w_3(A)$, $w_2(B)$

How many minimum numbers of moves (where a move consisting of changing the position of one of the operations) are required to convert S into a conflict serializable schedule?

(a) 1

(b) 2

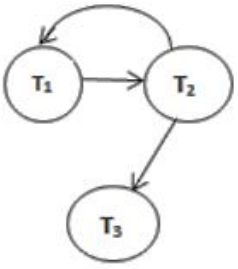
(b) 3

(d) 4

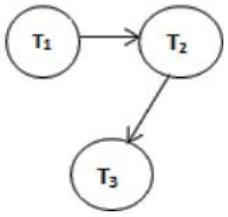
**Solution**: Option (a)

**Explanation**:

Precedence graph for the given schedule is:



If $w_1(B)$ is shifted after $r_1(B)$ then the schedule is $r_2(A)$, $r_1(B)$, $w_1(B)$, $w_2(A)$, $r_2(B)$, $r_3(A)$, $w_3(A)$, $w_2(B)$, then precedence graph becomes:




Now S is serializable schedule.

3. Consider 2 schedules $S_1$ and $S_2$ with same set of transactions and precedence graph of $S_1$ is same as precedence graph of $S_2$. Which of the following statement is True?

(a) Both $S_1$ and $S_2$ are conflict equal and conflict serializable schedule

(b) Both $S_1$ and $S_2$ are conflict equal but may not conflict serializable schedule

(c) Both $S_1$ and $S_2$ are conflict equal but may not equal schedules

(d) Both $S_1$ and $S_2$ are conflict equal and but may not view equivalent

**Solution**: Option (b)

**Explanation**:

Both $S_1$ and $S_2$ are conflict equal but may not conflict serializable schedule.

If either of $S_1$ or $S_2$ is serial schedule then $S_1$ and $S_2$ become conflict serializable schedule otherwise not.

4. Which of the following schedules are recoverable?

$S_1$: $r_1(x)$, $r_2(z)$, $r_1(z)$, $r_3(x)$, $r_3(y)$, $w_1(x)$, $C_1$, $w_3(y)$, $C_3$, $r_2(y)$, $w_2(y)$, $w_2(z)$, $C_2$

$S_2$: $r_1(x)$, $r_2(z)$, $r_1(z)$, $r_3(x)$, $r_3(y)$, $w_1(x)$, $w_3(y)$, $r_2(y)$, $w_2(z)$, $w_2(y)$, $C_1$, $C_2$, $C_3$

$S_3$: $r_1(x)$, $r_2(z)$, $r_3(x)$, $r_1(z)$, $r_2(y)$, $r_3(y)$, $w_1(x)$, $C_1$, $w_2(z)$, $w_3(y)$, $w_2(y)$, $C_3$, $C_2$

(a) Only $S_1$

(b) Only $S_1$, $S_3$

(c) Only $S_2$, $S_3$

(d) All $S_1$, $S_2$, $S_3$

**Solution**: Option (b)

**Explanation**:

We know that in recoverable, if $T_i$ reads a value written by $T_j$, then $T_i$ must commit after $T_j$ commits.

In $S_2$: $w_3$ (y) is first and $r_2$(y) appears second. Hence, $C_2$ should appear after $C_3$. But here $C_3$ is appearing after $C_2$. So, $S_2$ is not recoverable. $S_1$ and $S_3$ are recoverable.

5. For the given schedule which of the following statement is true?

S: $R_4(A)$, $R_2(A)$, $R_3(A)$, $W_1(B)$, $W_2(C)$, $R_4(B)$, $W_2(B)$

(a) The schedule cannot be serialized

(b) The schedule is equivalent to $T_3$, $T_4$, $T_1$, $T_2$

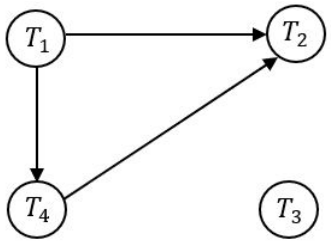
(c) The schedule is equivalent to $T_1$, $T_4$, $T_2$, $T_3$

(d) The schedule is equivalent to $T_2$, $T_3$, $T_1$, $T_4$

**Solution**: Option (c)

**Explanation**:

| $T_1$ | $T_2$ | $T_3$ | $T_4$ |
|---|---|---|---|
| | | | $R_4(A)$ |
| | $R_2(A)$ | | |
| | | $R_3(A)$ | |
| $W_1(B)$ | | | |
| | $W_2(C)$ | | |
| | | | $R_4(B)$ |
| | $W_2(B)$ | | |




$T_1 - T_4 - T_2 - T_3$

## COMMON DATA QUESTIONS

6. Consider the following schedules:

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

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

$S_3$: $R_1(A)$, $W_1(A)$, $R_2(B)$, $W_2(A)$, $R_1(B)$, $W_1(B)$, $R_1(C)$, $R_2(C)$

$S_4$: $R_2(B)$, $R_1(A)$, $W_2(A)$, $W_1(A)$, $R_1(B)$, $W_1(B)$, $R_2(C)$, $R_1(C)$

Which of the above schedule(s) is/are conflict serializable?

(a) $S_1$ and $S_2$ only

(b) $S_2$ only

(c) $S_1$ only

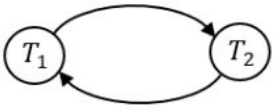
(d) None of these

**Solution**: Option (b)

**Explanation**:

$S_1$ :

| $T_1$ | $T_2$ |
|---|---|
| $R_1(A)$ | |
| $W_1(A)$ | |
| | $R_2(B)$ |
| $R_1(B)$ | |
| $W_1(B)$ | |
| | $W_2(A)$ |
| | $R_2(C)$ |
| $R_1(C)$ | |




∴ $S_1$ is not Conflict serializable

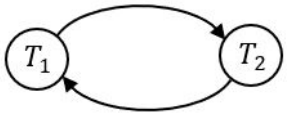
$S_2$ :

| $T_1$ | $T_2$ |
|---|---|
| | $R_2(B)$ |
| | $W_2(A)$ |
| $R_1(A)$ | |
| $W_1(A)$ | |
| $R_1(B)$ | |
| $W_1(B)$ | |
| | $R_2(C)$ |
| $R_1(C)$ | |


$\therefore$ $S_2$ is Conflict serializable and
$S_2$ is conflict serializable to $T_2 - T_1$.

$S_3$ :

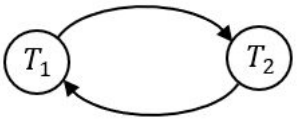
| $T_1$ | $T_2$ |
|---|---|
| $R_1(A)$ | |
| $W_1(A)$ | |
| | $R_2(B)$ |
| | $W_2(A)$ |
| $R_1(B)$ | |
| $W_1(B)$ | |
| $R_1(C)$ | |
| | $R_2(C)$ |




$\therefore$ $S_3$ is not Conflict serializable

$S_4$ :

| $T_1$ | $T_2$ |
|---|---|
| | $R_2(B)$ |
| $R_1(A)$ | |
| | $W_2(A)$ |
| $W_1(A)$ | |
| $R_1(B)$ | |
| $W_1(B)$ | |
| | $R_2(C)$ |
| $R_1(C)$ | |



$\therefore$ $S_4$ is not Conflict serializable

7. Which of the following is TRUE with regards to the correct answer for the above question?

(a) $S_1$ is conflict serializable to $T_1$, $T_2$

(b) $S_2$ is conflict serializable to $T_2$, $T_1$

(c) Both (A) and (B)

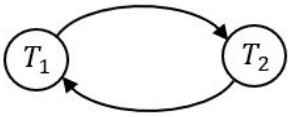
(d) None of these

**Solution**: Option (b)

**Explanation**:

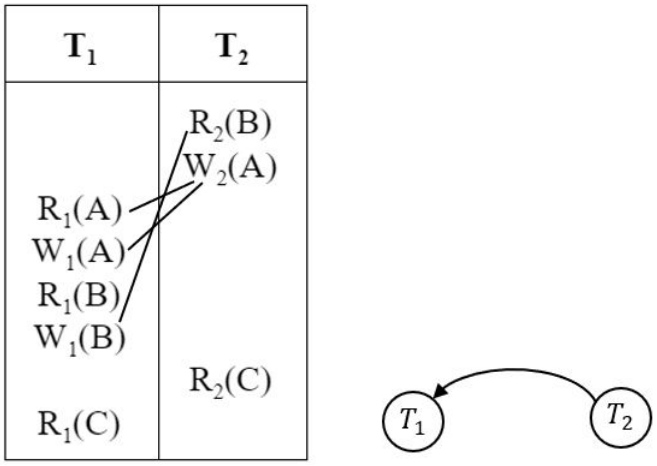
$S_1$ :

| $T_1$ | $T_2$ |
|---|---|
| $R_1(A)$ | |
| $W_1(A)$ | |
| | $R_2(B)$ |
| $R_1(B)$ | |
| $W_1(B)$ | |
| | $W_2(A)$ |
| | $R_2(C)$ |
| $R_1(C)$ | |




$\therefore$ $S_1$ is not Conflict Serializable.

$S_2$ :




$\therefore$ $S_2$ is Conflict Serializable and $S_2$ is conflict serializable to $T_2 - T_1$.

8. Which among the following 2-phase locking protocols is a deadlock free?

(a) Basic 2PL

(b) Strict 2PL

(c) Rigorous 2PL

(d) Conservative 2PL

**Solution**: Option (d)

**Explanation**:

Conservative 2-PL is Deadlock free and but it does not ensure Strict schedule

**Given below are some transaction schedules that involve three transactions: $T_1$-$T_2$-$T_3$**

Schedule 1:

$T_2$: $R_x$, $T_2$: $R_y$, $T_1$: $W_x$, $T_3$: $W_y$, $T_3$: $W_z$, $T_1$: $R_z$, $T_2$: $W_y$

Schedule2:

$T_2$: $R_x$, $T_2$: $W_y$, $T_3$: $R_y$, $T_3$: $W_x$, $T_1$: $W_y$, $T_3$: $R_x$, $T_1$: $R_y$, $T_2$: $W_y$

Schedule 3:

$T_1$: $R_x$, $T_2$: $R_y$, $T_3$: $W_y$, $T_2$: $R_z$, $T_3$: $R_z$, $T_1$: $W_z$, $T_1$: $W_y$, $T_2$: $W_y$

Schedule 4:

$T_1$: $R_x$, $T_3$: $W_y$, $T_2$: $R_z$, $T_3$: $R_z$, $T_1$: $W_y$, $T_2$: $W_x$, $T_1$: $R_y$, $T_2$: $W_z$

9. Which of the given schedules is conflict serializable?

(a) Schedule 1

(b) Schedule 2

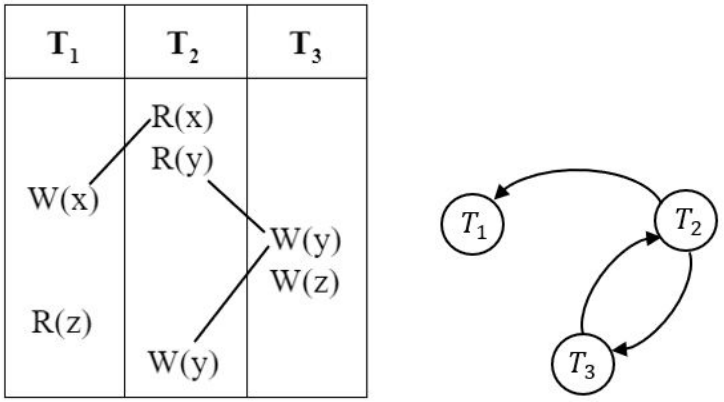
(c) Schedule 3

(d) Schedule 4

**Solution**: Option (d)

**Explanation**:

Schedule 1:

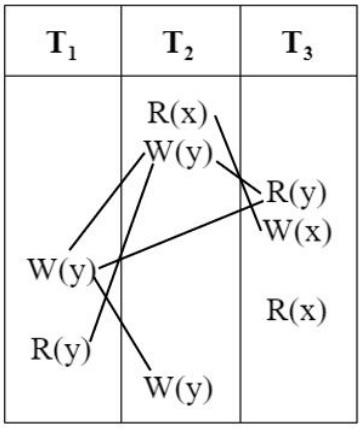


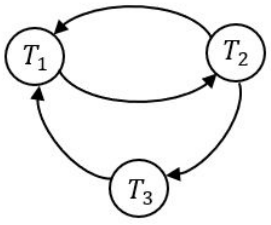




There is a cycle in the precedence graph. Hence, schedule 1 is not conflict serializable.

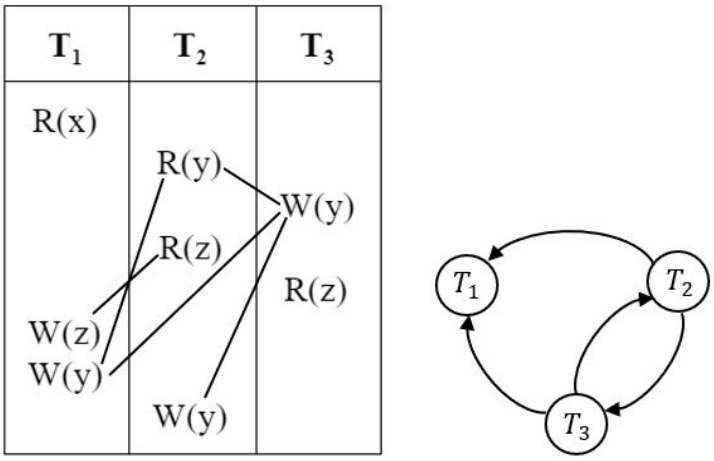
Schedule 2:



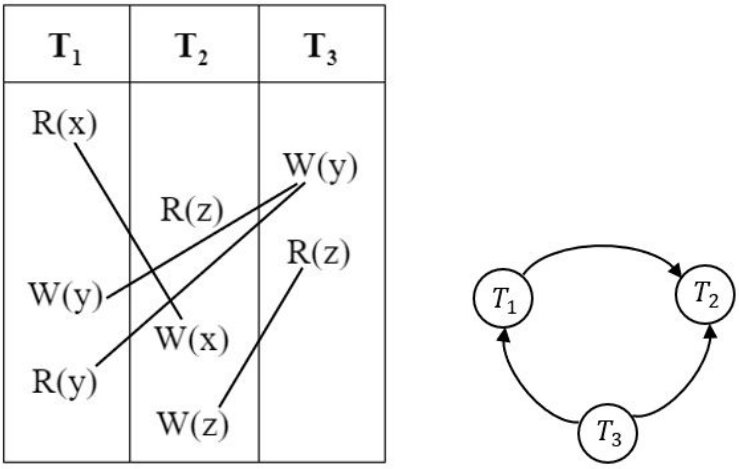

There is a cycle in the precedence graph. Hence, schedule 2 is not conflict serializable.

Schedule 3:




There is a cycle in the precedence graph. Hence, Schedule 3 is not conflict serializable.

Schedule 4:




There is no cycle in the precedence graph. Hence, schedule 4 is conflict serializable and equivalent serial schedule possible is $T_3 - T_1 - T_2$.

10. For the conflict serializable schedule found in the previous question, the equivalent serial schedule possible:

(a) $T_3$ - $T_1$ - $T_2$

(b) $T_2$ - $T_1$ - $T_3$

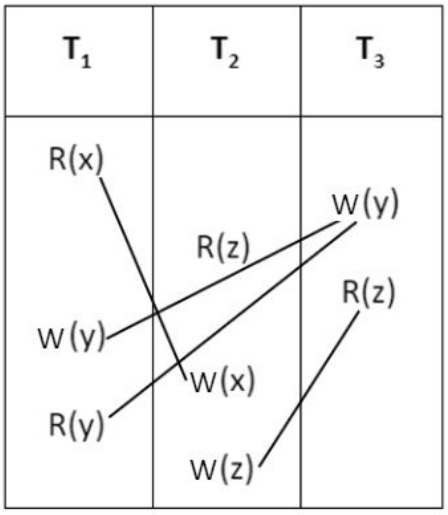
(c) $T_3$ - $T_2$ - $T_1$

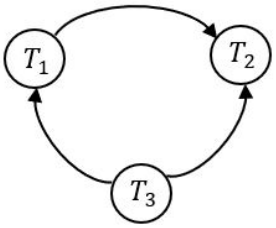
(d) None of these

**Solution**: Option (a)

**Explanation**:

Schedule 4:




There is no cycle in the precedence graph. Hence, schedule 4 is Conflict Serializable and equivalent serial schedule possible is $T_3 - T_1 - T_2$ .

11. Which of the following is True about the given schedule 'S'?

| $T_1$ | $T_2$ |
|---|---|
| R(A)<br>A=A+100 | |
| | R(A)<br>A=A*2<br>W(A) |
| W(A) | |
| | R(B)<br>B= B/2<br>W(B) |
| R(B)<br>B= B-100<br>W(B) | |

(a) It is conflict serializable

(b) It is view serializable but not conflict serializable

(c) It is conflict serializable but not view serializable

(d) It is not serializable

**Solution**: Option (d)

**Explanation**:

The given schedule is not serializable, since it is not conflict serializable, not view serializable.

12. Which among the following schedules is an irrecoverable schedule?

(a)

| $T_1$ | $T_2$ |
|---|---|
| | R(A) |
| | W(A) |
| R(A) | |
| W(A) | |
| | Commit |
| Abort | |

(b)

| $T_1$ | $T_2$ |
|---|---|
| R(A) | |
| W(A) | |
| | R(A) |
| | W(A) |
| Abort | |
| | Abort |

(c)

| $T_1$ | $T_2$ |
|---|---|
| R(A) | |
| W(A) | |
| Abort | |
| | R(A) |
| | W(A) |
| | Commit |

(d)

| $T_1$ | $T_2$ |
|---|---|
| R(A) | |
| W(A) | |
| | R(A) |
| | W(A) |
| | Commit |
| Abort | |

**Solution**: Option (d)

**Explanation**:

For option (d), in the schedule the transaction T2 is performing a dirty read operation from an uncommitted transaction T1 and committing before the transaction from which it has read the value. Hence, it is irrecoverable schedule.

13. Suppose a schedule with 2 transactions $T_1$ and $T_2$:

| $T_1$ | $T_2$ |
|---|---|
| Read(A)<br>Write(A) | |
| | Read(A)<br>Commit |
| Read(A)<br>Abort | |

The above schedule is:

(a) Cascadeless schedule

(b) Recoverable schedule

(c) Irrecoverable schedule

(d) None of these

**Solution**: Option (c)

**Explanation**:

As the value of a data is read by transaction who has committed but thereafter the transaction, which changed the value of data got aborted, so it is Irrecoverable schedule.

14. There are 2 transactions, $T_1$ with 2 instructions and $T_2$ with 5 instructions. Find the number of Serial and concurrent schedules respectively.

(a) 2, 2

(b) 21, 21

(c) 2, 20

(d) 21, 2

**Solution**: Option (c)

**Explanation**:

No. of serial schedules = No. of transactions = 2

No. of concurrent schedules $= \frac{(5+2)!}{5!2!} - 2! = 21 - 2 = 20$

15. Which of the following statements are true about recoverable and cascadeless schedules?

(P) All cascadeless schedules are also recoverable
(Q) All recoverable schedules are also cascadeless schedules
(R) All strict schedules are cascadeless and recoverable
(S) All cascadeless and recoverable schedules are strict schedule

(a) P and R are correct

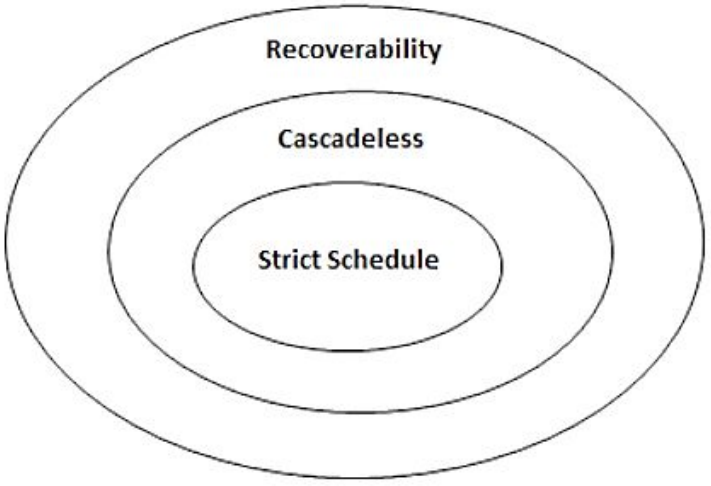
(b) P and S are correct

(c) P, R and S are correct

(d) P, Q and S are correct

**Solution**: Option (a)

**Explanation**:

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