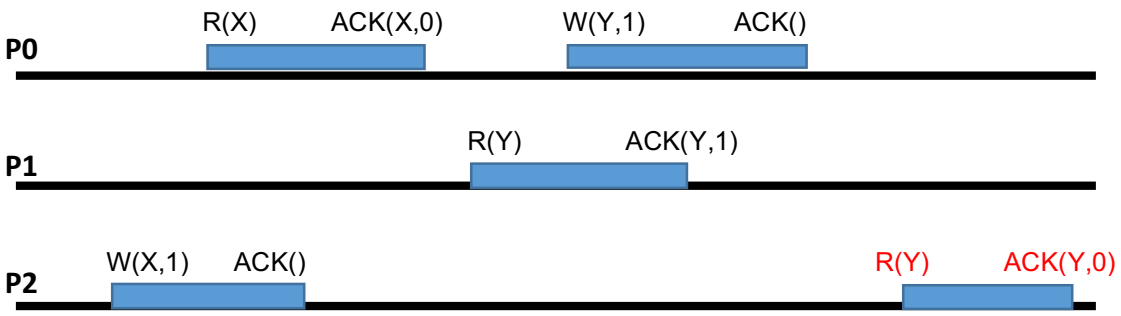
CS425/ECE428 Distributed Systems
Homework 3 Solutions

Total 30 points

1. In each part of this question, if you answer NO, then delete a minimum number of operations to ensure that the modified execution will satisfy the specified property – circle the operations that you want to delete.

   Assume that all variables are initialized to 0.

   a. Is the execution below linearizable? Explain your answer briefly. **(5 points)**

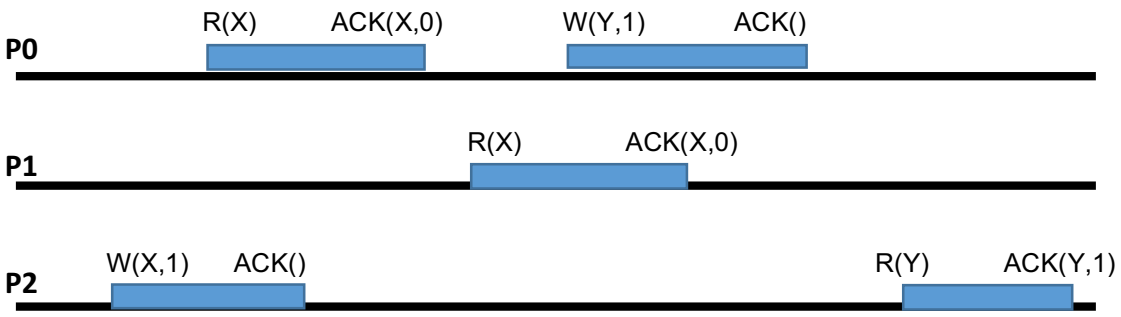


Answer:
No. The last read operation on P2 returns Y=0 even though P0 has already written value 1 to Y (violates real-time order preserving requirement). Deleting P2 R(Y) operation will make the execution linearizable.

Grading policy:
For YES answer, 0 points on part (a)

+2 for answering NO (no credit otherwise)
+1 for explanation
+ 2 deleting the correct operation, no points otherwise

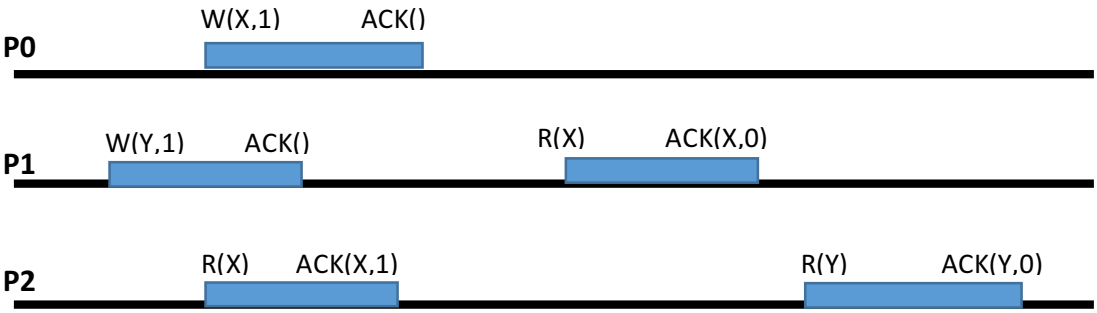
b. Is the execution below sequentially consistent? **(5 points)**



Answer:
Yes

Grading policy:
5 points for correct answer, 0 otherwise

c. Is the execution below sequentially consistent? **(5 points)**



Answer:

No.

To make the execution sequentially consistent, any of the answers below is acceptable.

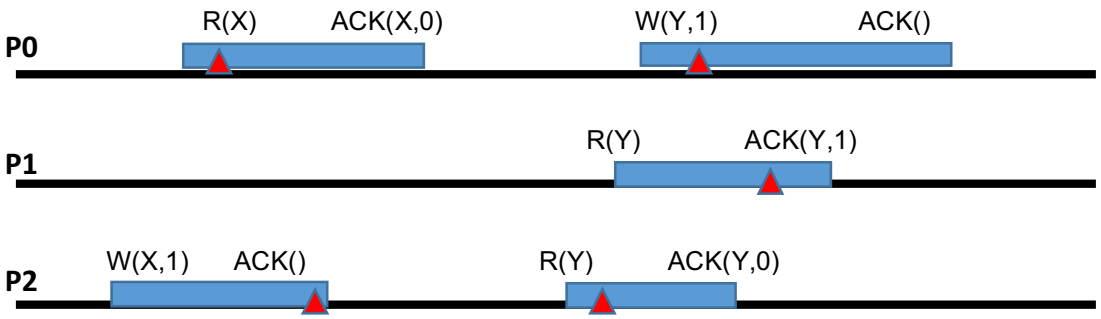
a. Delete first write operation W(Y,1) on P1.
b. Delete first read operation R(X) on P2.
c. Delete last read operation R(Y) on P2.

Grading policy:

For YES answer, 0 points on part (c)

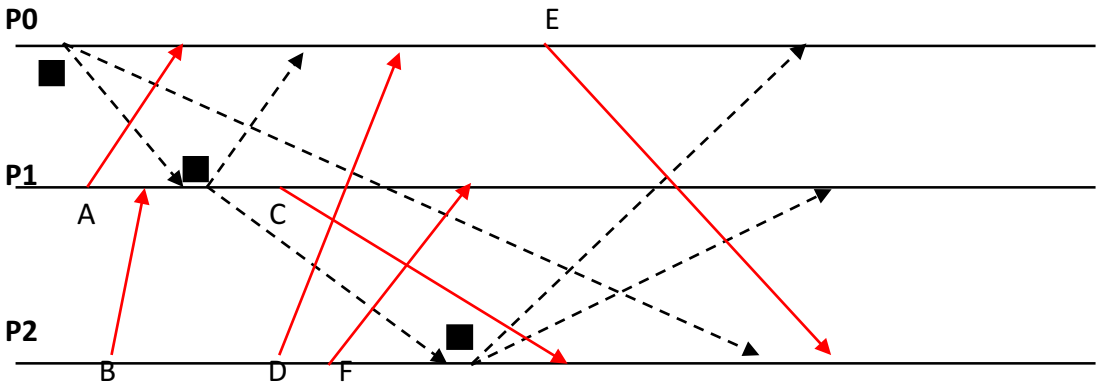
+2 points for answering NO
+3 for any one correct delete operation

2. Given below is a linearizable execution, draw linearization points (as triangles) for each of the operations. **(5 points)**



Grading policy:
1 point for each correct red triangle

3. Using Chandy-Lamport algorithm, show when each process records its local state (you can annotate the figure) and list the channel states for each process captured in the snapshot. Black dotted lines are marker messages. Red lines are messages (A to F). **(10 points)**



Answer:
Local states are annotated as a black square in the figure above.
Channel states are listed below.
Process P0:

$C_{10} = \{A\}$
$C_{20} = \{D\}$

Process P1:

$C_{01} = \{\}$
$C_{21} = \{F\}$

Process P2:

$C_{02} = \{\}$
$C_{12} = \{\}$

Grading policy:
4 points if all process states marked correctly
2 points if two process states marked correctly

6 points if all six channel states shown correctly
4 points if 5 channel states shown correctly
2 points if 4 channel states shown correctly