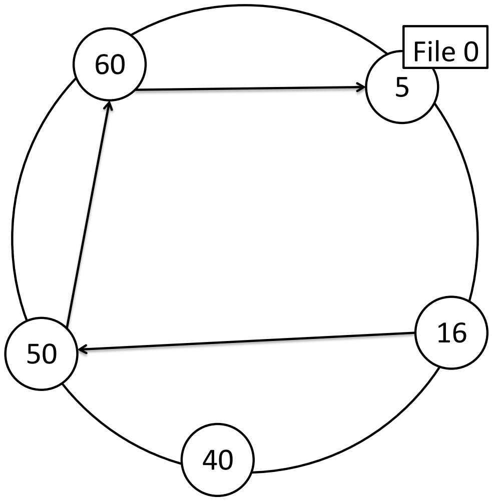
1a) 1b)



Node	Finger Table					
	Entry no.					
	0	1	2	3	4	5
5	16	16	16	16	40	40
16	40	40	40	40	40	50
40	50	50	50	50	60	16
50	60	60	60	60	5	40
60	5	5	5	5	16	40

1c)

We accepted any of the following two answers:

1. Average size of a finger table is $\log_2 N = \log_2 5 \sim 3$
2. Average size of a finger table (in this example) is = (2+2+2+3+3)/5 = 13/5 = 2.6

1d)

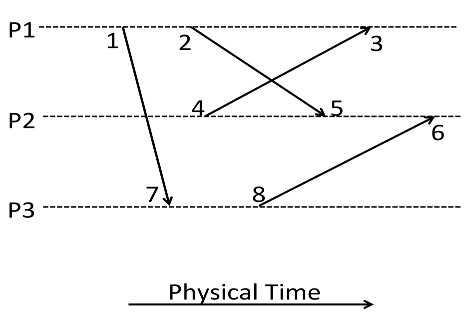
Node 5 stores the file with ID 0. The steps (16 – 50 – 60 – 5) are shown in the figure.

1e)

The file with ID 0 is moved from node 5 to node 4 since files with IDs 61~4 now belong to node 4 instead of node 5.

Some of you mentioned about successor and predecessor. You got 1 point if you mentioned successor of 60 is 4 and successor of 4 is 5, and predecessor of 5 is 4 and predecessor of 4 is 60.

2)



Event	Concurrent Event(s)
1	4
2	4, 7, 8
3	5, 6, 7, 8
4	1, 2, 7, 8
5	3, 7, 8
6	3
7	2, 3, 4, 5
8	2, 3, 4, 5

3)

The conditions were taught in class. Each condition has two points, and you got 1 point for each.

- Safety: ∀ non-faulty process p: (p's elected = (q: a particular non-faulty process with the best attribute value) or ⊥)
- Liveness: ∀election: (election terminates) & ∀ p : non faulty process, p's elected is not ⊥

4)

Assume external clock is at S(t), and two physical clocks read $C_1(t)$ and $C_2(t)$. Since $C_1(t)$ and $C_2(t)$ are externally synchronized within bound D>0, in the worst case one of them can be at +D and one of them can be at –D.

Assume

$C_1(t) = S(t) + D$ … … … (1)

$C_2(t) = S(t) - D$ … … … (2)

Hence, (1) – (2)

$C_1(t) - C_2(t) = 2D$

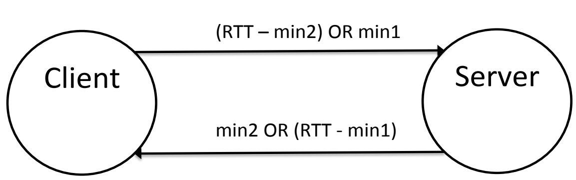
Similarly, it can be shown that $C_1(t) - C_2(t) = -2D$

Therefore $C_1(t)$ and $C_2(t)$ can be maximum 2D apart from each other.

So, $|C_1(t) - C_2(t)| < 2D$

We also accepted your answer if you just explained the above in words.

5)



The actual time can be anytime between (T+min2) or (T + (RTT-min1)), where T is

6:00PM, RTT is 7 sec, min1=2sec (the minimum one way transmission time from client to server), and min2=1sec(the minimum one way transmission time from server to client).

The two extremes are:

(6:00+ 1 sec) = 6:00:01 PM and

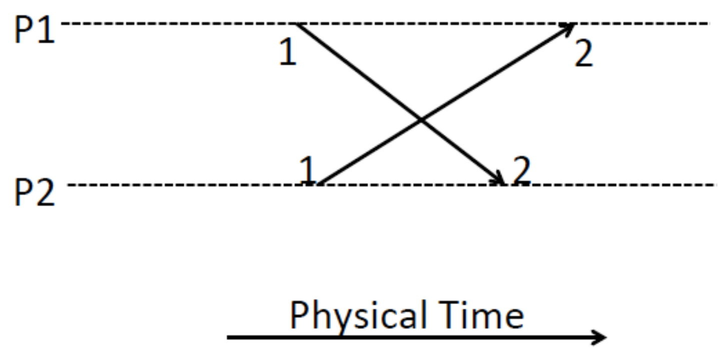
(6:00+ (7-2) sec) = 6:00:05 PM

The client sets its time to the mid point of the two extremes, i.e.,

(6:00:05 + 6:00:01)/2

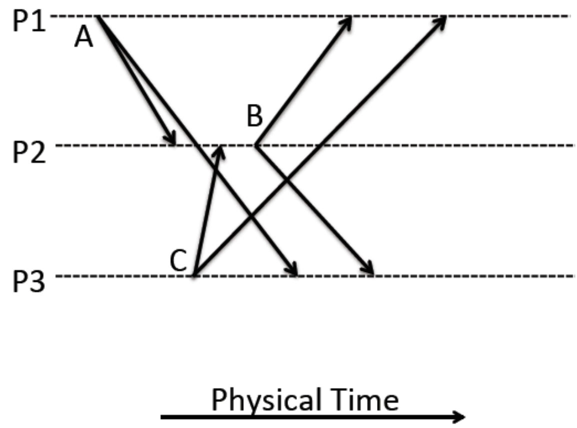
= 6:00:03 PM

6a) False. The following figure is a counter example.



6b) True. The reason is that every process *i* increments the *i* th element of its vector upon send or receive event. Also, in receiving a message from process *j≠i,* $V_{receiver}[j]$ is set to $Max(V_{receiver}[j]$, $V_{message}[j])$. In this way, events are always assigned different vector timestamps.

6c) False. The following figure shows a counter example, in which causal ordering is satisfied, while total ordering is violated. In this figure, A->B and every process delivers A first and then B. So, it satisfies causal ordering. But it violates total ordering, since P1 delivers B first and then C, while p2 delivers C before B.



7) (a) 1-6, 4-5, and 7-8.
(b) No. You can reorder 4 and 5 and that would work.
(c) Transaction X would block acquiring a write lock on C at step 5
(d) Yes, deadlock would occur. At step 6, transaction Y would wait for a write lock on A, while X is waiting for a lock on C.

8) Preconditions are:
- Exclusive access to a resource
- Circular wait
- No preemption

Edge-chasing violates no preemption because it aborts a transaction once a cycle has been found.