**Question 1.** Assume the following trace for the ticket lock for a 3-processor system and fill the following table with constraints as given. Use the MSI protocol

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Steps | next\_ ticket | now\_ serving | my\_ticket | | | State  (next\_ticket) | | | State  (now\_serving) | | | Comments |
| P1 | P2 | P3 | P1 | P2 | P3 | P1 | P2 | P3 |
| Initially | 0 | 0 | 0 | 0 | 0 | I | I | I | I | I | I | All initialized to zero |
| P1: fetch & inc |  |  |  |  |  |  |  |  |  |  |  |  |
| P2: fetch & inc |  |  |  |  |  |  |  |  |  |  |  |  |
| P1: now\_serving++ |  |  |  |  |  |  |  |  |  |  |  |  |
| P3: fetch & inc |  |  |  |  |  |  |  |  |  |  |  |  |
| P2: now\_serving++ |  |  |  |  |  |  |  |  |  |  |  |  |
| P3: now\_serving++ |  |  |  |  |  |  |  |  |  |  |  |  |

**Question 2.** Suppose all variables are initalized to 0 and two processors execute the following code:

|  |  |
| --- | --- |
| *P*­1 | *P*­2 |
| 1a A = 1  1b a = A  1c c = B  1d print b | 2a B = 1  2b b = B  2c print a, c |

(a) *(8 points)* Which of the eight combinations of values for (a, b, c) can be printed under sequential consistency?

(b) *(4 points)* Choose one of the combinations that is impossible and explain why it is not possible under sequential consistency.

(c) *(4 points)* Under processor consistency, which—if any—additional combinations of values can be printed? How?

(d) *(4 points)* Under weak ordering, which—if any—additional combinations of values can be printed? How?