CS372 Operating System
HW4

. **7.12** Assume a multithreaded application uses only reader — writer locks for synchronization. Applying the four necessary conditions for deadlock, is deadlock still possible if multiple reader—writer locks are used?

. **Answer:** YES. (1) Mutual exclusion is maintained, as they cannot be shared if there is a writer. (2) Hold-and-wait is possible, as a thread can hold one reader —writer lock while waiting to acquire another. (3) You cannot take a lock away, so no preemption is upheld. (4) A circular wait among all threads is possible.

. **7.19** Consider the version of the dining-philosophers problem in which the chopsticks are placed at the center of the table and any two of them can be used by a philosopher. Assume that requests for chopsticks are made one at a time. Describe a simple rule for determining whether a particular request can be satisfied without causing deadlock given the current allocation of chopsticks to philosophers.

. **Answer:** The following rule prevents deadlock: when a philosopher makes a request for the first chopstick, do not grant the request if there is no other philosopher with two chopsticks and if there is only one chopstick remaining.

7.22 Consider the following snapshot of a system:

	Allocation	**Max**
	A B C D	*A B C D*
P_0	3 0 1 4	5 1 1 7
P_1	2 2 1 0	3 2 1 1
P_2	3 1 2 1	3 3 2 1
P_3	0 5 1 0	4 6 1 2
P_4	4 2 1 2	6 3 2 5

Using the banker's algorithm, determine whether or not each of the following states is unsafe. If the state is safe, illustrate the order in which the processes may complete. Otherwise, illustrate why the state is unsafe.

a) **Available** = (0, 3, 0, 1)

b) **Available** = (1, 0, 0, 2)

Answer:

a) Not safe. Processes P_2, P_1, and P_3 are able to finish, but no remaining processes can finish.

b) Safe. Processes P_1, P_2, and P_3 are able to finish. Following this, processes P_0 and P_4 are also able to finish.

7.23 Consider the following snapshot of a system:

	Allocation	**Max**	**Available**
	A B C D	*A B C D*	*A B C D*
P_0	2 0 0 1	4 2 1 2	3 3 2 1
P_1	3 1 2 1	5 2 5 2	
P_2	2 1 0 3	2 3 1 6	
P_3	1 3 1 2	1 4 2 4	
P_4	1 4 3 2	3 6 6 5	

Answer the following questions using the banker's algorithm:

a) Illustrate that the system is in a safe state by demonstrating an order in which the processes may complete.

b) If a request from process P_1 arrives for (1, 1, 0, 0), can the request be granted immediately?

c) If a request from process P_4 arrives for (0, 0, 2, 0), can the request be granted immediately?

Answer:

a) P_0, P_3, P_1 , P_2 and P_4.

b) Safe. P_0, P_3, P_1 , P_2 and P_4 can be the sequence to complete the processes.

c) Not safe. We cannot find a sequence to complete the processes in safe state.