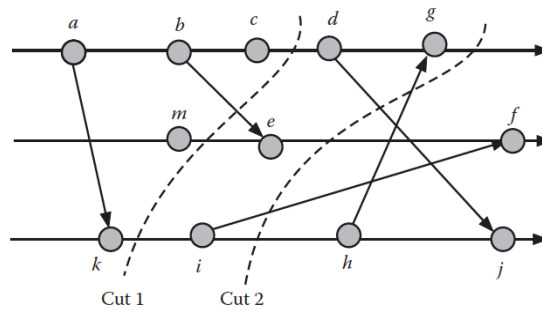


## Homework 2 (27 points)

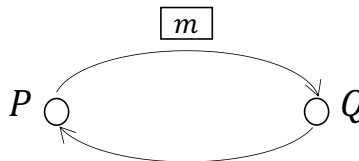
Due 03/11/21 before class

Clearly justify your answers to each of the questions below.

- 1 (4 points) The figure below shows two cuts in a distributed system of three processes. Are they consistent? Explain.



- 2 (6 points) Two processes  $P$  and  $Q$  are connected in a ring using two channels, and they constantly rotate a token  $m$ . At any one time, there is only one copy of  $m$  in the system. Each process's state consists of the number of times it has received  $m$ , and  $P$  sends  $m$  first. At a certain point,  $P$  has the token and its state is 101. Immediately after sending  $m$ ,  $P$  initiates the Chandy and Lamport's snapshot algorithm. Explain the operation of the algorithm in this case, giving the possible global state(s) reported by it.



- 3 (8 points) Some applications require two types of accesses to the critical section - *read* access and *write* access. For these applications, it is reasonable for two *read* accesses to happen concurrently. However, a *write* access cannot happen concurrently with either a *read* access or a *write* access. Modify the Ricart-Agrawala algorithm for such applications.
- 4 (5 points) In the Chang-Roberts algorithm we discussed in class, a process does not distinguish Election/Elected messages from different initiators. Modify the algorithm to suppress unnecessary Election/Elected messages to make it more communication efficient in the presence of multiple initiators.

5 (4 points) What is the worst-case turnaround time in a single run of the bully algorithm?  
Assume that there are no failures during the run.