CSE 461/660 Advanced Operating Systems (Concepts & Theory)

Homework 2
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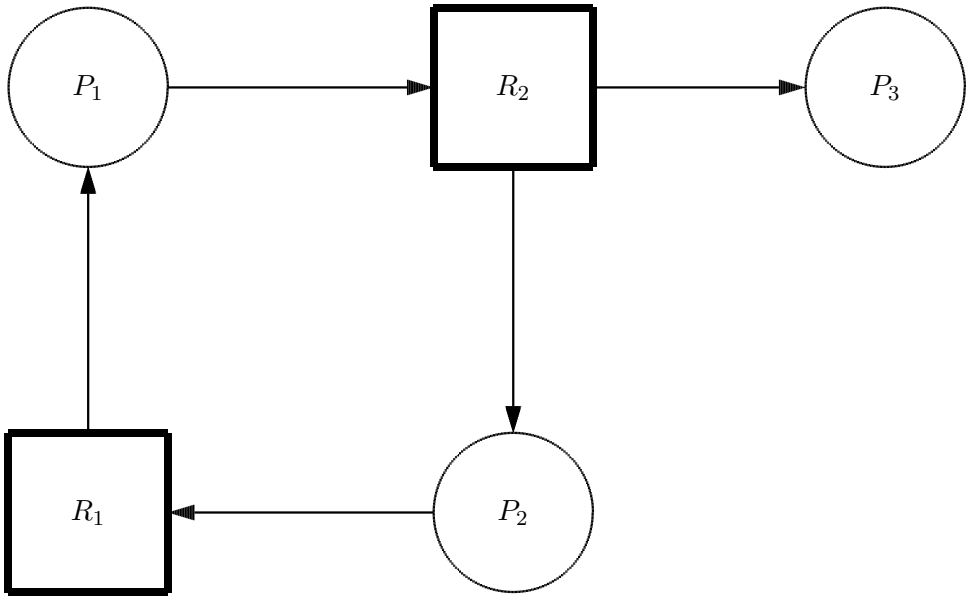
1. (10 points)
   The following figure shows a resource graph for a system with consumable resources only. A resource is represented by a rectangle with thick lines and labeled as R_i. A process is represented by a circle, labeled P_i.

   (a) Is the graph a claim-limited graph? Why?
   (b) Is the graph reducible? Why?

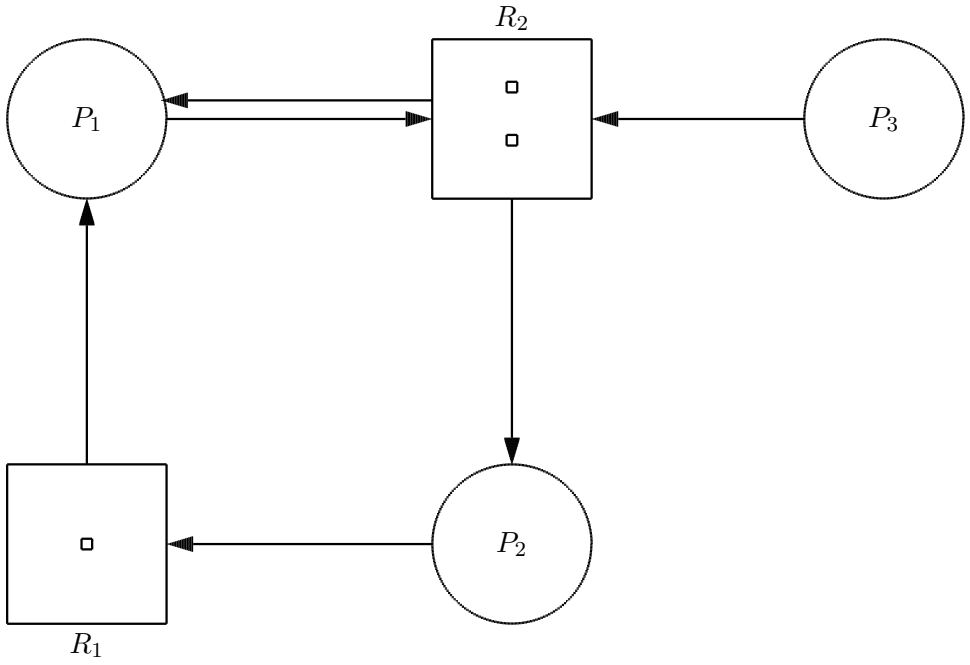


2. (10 points)
   Assume a system has P processes and R identical units of a reusable resource. If each process can claim at most N units of the resource, determine whether each of the following is true or false and prove your claim:

   (a) If the system is deadlock free then $R \geq P(N-1)+1$.
   (b) If $R \geq P(N-1)+1$ then the system is deadlock free.

3. (10 points)
   The following figure shows a resource graph for a system with reusable resources only. A resource is represented by a rectangle, in which a small square indicates a unit of the resource.

   (a) Is the graph expedient? Why?
   (b) Is there any knot in the graph? Why?
   (c) Is there any deadlock in the system? Why?



4. (10 points)
   In this problem you are to compare reading a file using a single-threaded file server and a multithreaded server. It takes 15 msec to get a request for work, dispatch it, and do the rest of the necessary processing, assuming that the data needed are in a cache in main memory. If a disk operation is needed, as is the case one-third of the time, an additional 75 msec is required, during which time the thread sleeps. How many requests/sec can the server handle if it is single threaded? If it is multithreaded?

5. (10 points)
   Consider the state of a system with processes P_1, P_2, and P_3, defined by the following matrices:

$$\begin{aligned} \text{max-Avail } A &= \begin{pmatrix} 5 & 2 & 4 \end{pmatrix} \\ \text{max-Claim } B &= \begin{pmatrix} 2 & 2 & 2 \\ 1 & 2 & 2 \\ 3 & 1 & 3 \end{pmatrix} \\ \text{Allocation } C &= \begin{pmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 1 & 1 & 1 \end{pmatrix} \end{aligned}$$

   (a) Find the *available* matrix D and the *need* matrix E in this state.
   (b) Suppose now process P_1 makes a request with

$$F_1 = \begin{pmatrix} 0 & 0 & 1 \end{pmatrix}$$

   If the request were granted, what would be D, C, and E in the resulted state?
   (c) To ensure the system be safe, should the request be granted? Why? Give your reasons in detail.