Modern Operating System Exercise 3

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Problem 1

a. The minimum value of K may cause deadlock is **4**.

In this case, if each process holds two printer resources and is waiting for the third and cannot be released, a deadlock will occur.

However, when K is equal to 3, the worst case is that three processes respectively occupy 3, 3 and 2 resources. At this time, the third process can wait until the first two processes release resources

b. **No**. There is no minimum value of K that must cause deadlock.

No matter how many processes there are, the system can take appropriate process synchronization method to allocate resources and avoid deadlock.

Problem 2

a. We have Need[i][j]=Max[i][j]-Allocation[i][j]. The content of the matrix Need is as follows.

Table 1: the Matrix Need Of Problem 2

	R1	R2	R3	R4
P0	0	0	0	0
P1	0	7	5	0
P2	6	6	2	2
P3	2	0	0	2
P4	0	3	2	0

b. **Yes**. The sequence ⟨P0,P3,P4,P1,P2⟩ can meet safety requirements. So the system is in a safe state.

c. **No**. There are not enough available resources to grant P2's request. P2 requires two R2 but there is only one free left.

Problem 3

a. The resource allocation graph is as follows.

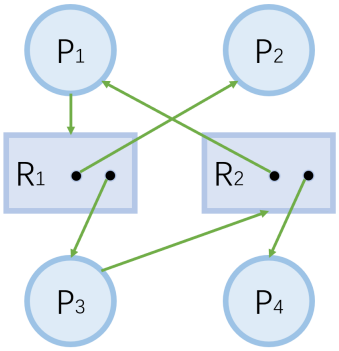

Fig. 1. Resource Allocation Graph of Problem 3

b. **Yes**. There is a cycle: P1 → R1 → P3 → R2 → P1

c. **No**. Although there is a cycle, there is no deadlock. Two possible sequence of executions are ⟨P4 → P3 → P1 → P2⟩ or ⟨P2 → P4 → P1 → P3⟩ .

Problem 4

Firstly, calculate the matrix Need.

Table 2: the Matrix Need Of Problem 4

	R1	R2	R3	R4	R5
Process A	0	1	0	0	2
Process B	0	2	1	0	0
Process C	1	0	3	0	0
Process D	0	0	1	1	1

To run in a safe state, we must first run process D and X should be no less than 1. Other process don't need R4 anymore. After verification, other resources also meet the conditions, so the minimum X is 1.