Sample Theory QUESTIONS

1. Consider a system with ten resources and four processes competing for them. Let process P1 have a maximum need of seven resources, process P2 have a maximum need of five resources, process P3 have a maximum need of eight resources and process P4 have a maximum need of six resources.

Let [a1, a2, a3, a4] represent the allocation vector with respect to the resources currently allocated to the processes P1 through P4, in that order. The system is deemed to be in a safe state with respect to an allocation vector if there is a possibility of allocating the remaining resources in such a way as to satisfy the maximum needs of all the processes.

Examine each of the following allocation vectors and determine if it is safe or not. Identify the one that is NOT safe?

a) [3, 0, 3, 1]
b) [3, 2, 0, 3]
c) [3, 2, 0, 2]
d) [4, 1, 1, 1]
e) [2, 3, 2, 0]

Answer:

Starting with each of the allocation vectors in the answer choices, determine if there exists a way the system can allocate the remaining resources so that the maximum needs of all the processes are taken care of.

For example, if the allocation vector is [3, 1, 0, 3], the system can first allocate P4 the remaining three resources and when P4 terminates, it can get back six resources from P4 that can be used to satisfy the needs of P2 and then P1 and then P3. Thus, the allocation vector [3, 1, 0, 3] corresponds to a safe system state.

In contrast, if the allocation vector is [3, 1, 3, 0] the system cannot satisfy the maximum need of any process with the three remaining resources and so the allocation vector [3, 1, 3, 0] does not correspond to a safe system state.

a) [3, 0, 3, 1] Not Safe
b) [3, 2, 0, 3] Not Safe
c) [3, 2, 0, 2] Safe
Explanation:
From this state, the system can satisfy the remaining resource needs for the processes by first allocating three more resources to P2, get five resources back from P2, allocate four more resources to P1, get seven resources back from P1,

allocate eight resources to P3, get eight resources back from P3, allocate four more resources to P4 and get six resources back from P4. Therefore, this allocation vector corresponds to a safe system state.

d) [4, 1, 1, 1] Safe
Explanation:
From this state, the system can satisfy the remaining resource needs for the processes by first allocating three more resources to P1, get seven resources back from P1, allocate four more resources to P2, get five resources back from P2, allocate seven more resources to P3, get eight resources back from P3, allocate five more resources to P4 and get six resources back from P4. Therefore, this allocation vector corresponds to a safe system state.

e) [2, 3, 2, 0] Safe
Explanation:
From this state, the system can satisfy the remaining resource needs for the processes by first allocating two more resources to P2, get five resources back from P2, allocate five more resources to P1, get seven resources back from P1, allocate six more resources to P3, get eight resources back from P3, allocate six resources to P4 and get six resources back from P4. Therefore, this allocation vector corresponds to a safe system state.

2. Consider a system employing a deadlock-avoidance scheme based on pre-declaration of resource needs for various processes. In particular, the resource needs of the processes are represented by claim arcs in the resource-allocation graph. Whenever a resource request by a process is issued, it is rejected by the system if the newly formed allocation arc (from the resource vertex to the process vertex) replacing the corresponding claim arc (from the process vertex to the resource vertex) closes a cycle in the resource-allocation graph. Otherwise, the system grants the request and converts the claim arc to the allocation arc in the resource-allocation graph.

Let P1, P2 and P3 be three processes in the system. Let P1 declare that it may request resources W, X and Y; P2 declare that it may request resources X, Y and Z; P3 declare that it may request resources W, Y and Z. Construct the resource-allocation graph with the appropriate claim arcs.

Consider each of the following pairs of resource requests. Based on the resource-allocation graph constructed above, identify the pair of requests among the following that can be granted without a deadlock possibility?

a) P1 requesting X and P2 requesting Z
b) P2 requesting Y and P3 requesting W
c) P1 requesting Y and P3 requesting W
d) P1 requesting X and P2 requesting Y

Answer:

a) P1 requesting X and P2 requesting Z (Safe)

Explanation:

Conversion of the claim arcs P1→X and P2→Z into allocation arcs X→P1 and Z→P2 will not introduce a cycle in the resource-allocation graph. So the system continues to be in a safe state even after granting the pair of requests.

b) P2 requesting Y and P3 requesting W (Safe)

Explanation:

Conversion of the claim arcs P2→Y and P3→W into allocation arcs Y→P2 and W→P3 will not introduce a cycle in the resource-allocation graph. So the system continues to be in a safe state even after granting the pair of requests.

c) P1 requesting Y and P3 requesting W (Not Safe)

Explanation:

The allocation arc from Y to P1, the claim arc from P1 to W, the allocation arc from W to P3 and the claim arc from P3 to Y form a cycle. So, these requests cannot both be granted by the deadlock-avoidance scheme. Note that if these two requests were to be granted, the two subsequent requests from P1 for W and from P3 for Y can lead to a deadlock.

d) P1 requesting X and P2 requesting Y (Not Safe)

Explanation:

The allocation arc from X to P1, the claim arc from P1 to Y, the allocation arc from Y to P2 and the claim arc from P2 to X form a cycle. So, these requests cannot both be granted by the deadlock-avoidance scheme. Note that if these two requests were to be granted, the two subsequent requests from P1 for Y and from P2 for X can lead to a deadlock.