Operating Systems Module: CO-562
Constructor University Date: 2024-10-11
Dr. Jürgen Schönwälder Due: 2024-10-18

Problem Sheet #6

Problem 6.1: *safe states* (3 points)

A system has $n = 5$ processes, $m = 5$ resource types, and the number of resources for each resource type is given by $t = (6, 17, 9, 10, 7)$. The system is in the following state:

$$M = \begin{bmatrix} 2 & 5 & 3 & 3 & 2 \\ 3 & 5 & 8 & 10 & 1 \\ 4 & 12 & 4 & 9 & 2 \\ 6 & 1 & 4 & 5 & 5 \\ 1 & 2 & 3 & 4 & 5 \end{bmatrix} \quad A = \begin{bmatrix} 0 & 5 & 3 & 1 & 1 \\ 0 & 2 & 1 & 1 & 1 \\ 0 & 7 & 1 & 2 & 1 \\ 3 & 1 & 1 & 1 & 0 \\ 1 & 2 & 3 & 2 & 1 \end{bmatrix}$$

Is the system in a safe state? Provide a calculation to justify your answer.

Problem 6.2: *deadlock detection* (1+2 = 3 points)

A system has $n = 3$ processes, $m = 4$ resource types, and the number of resources for each resource type is given by $t = (2, 2, 1, 3)$. The system is in the following state:

$$A = \begin{bmatrix} 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \end{bmatrix} \quad N = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$

a) Draw the corresponding resource allocation graph.

b) Is the system deadlocked? Provide a calculation to justify your answer.

Problem 6.3: *scheduling strategies* (4+2 = 6 points)

A computer system with a single CPU has to execute $n = 6$ processes $A, \ldots, F$. The arrival times and the execution times of the processes are given by the following table.

process	arrival time	execution time
A	0	7
B	3	5
C	5	9
D	8	3
E	10	1
F	12	2

a) Draw the schedule for the scheduling strategies first-come first-served (FCFS), shortest processing time first (SPTF), longest processing time first (LPTF), and round robin (RR) with a time slice of 1 time unit. Assume that arrivals happen before a scheduling point and that new processes are added at the end of the run queue.

b) For each schedule, calculate the average turnaround time $\bar{t}$ and the average waiting time $\bar{w}$.