

*Pledge: I pledge my honor that I have abided by the Stevens Honor System. - Eric Altenburg*

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**1: Does the busy waiting solution using the turn variable (Fig 2-23 in the book) solves the mutual exclusion problem when two processes are running on a shared-memory multiprocessor, that is, two CPUs sharing a common memory?**

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Yes, the busy waiting solution using the turn variable solves the mutual exclusion problem when two processors are running on a shared-memory multiprocessor. From the figure, the "turn" variable is used to control the critical region between the two processes, and in this case, since it is on a multiprocessor, the two processes are running on different CPUs; however, the "turn" variable should now be in the shared-memory.

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**2: Five batch jobs. A through E, arrive at a computer center at almost the same time. They have estimated running times of 10, 6, 2, 4, and 8 minutes. Their (externally determined) priorities are 3, 5, 2, 1, and 4, respectively, with 5 being the highest priority. For each of the following scheduling algorithms, determine the mean process turnaround time. Ignore process switching overhead.**

- a Round robin.
- b Priority scheduling.
- c First-come, first-served (run in order 10, 6, 2, 4, 8).
- d Shortest job first.

For (a), assume that the system is multiprogrammed, and that each job gets its fair share of the CPU. For (b) through (d), assume that only one job at a time runs, until it finishes. All jobs are completely CPU bound.

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All batch jobs have been assigned a letter (a-e) in the order they were stated.

(a)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	B	C	D	E	A	B	C	D	E	A	B	D	E	A

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
B	D	E	A	B	E	A	B	E	A	E	A	E	A	A

The turnaround times in minutes for each job are as follows:

A 30  
B 23  
C 8  
D 17  
E 28

Mean Process Turnaround Time =  $\frac{30+23+8+17+28}{5} = 21.2$  minutes

(b)

1-6	7-14	15-24	25-26	27-30
B	E	A	C	D

The turnaround times in minutes for each job are as follows:

A 24

B 6

C 26

D 30

E 14

$$\text{Mean Process Turnaround Time} = \frac{24+6+26+30+14}{5} = 20 \text{ minutes}$$

(c)

1-10	11-16	17-18	19-22	23-30
A	B	C	D	E

The turnaround times in minutes for each job are as follows:

A 10

B 16

C 18

D 22

E 30

$$\text{Mean Process Turnaround Time} = \frac{10+16+18+22+30}{5} = 19.2 \text{ minutes}$$

(d)

1-2	3-6	7-12	13-20	21-30
C	D	B	E	A

The turnaround times in minutes for each job are as follows:

A 30

B 12

C 2

D 6

E 20

$$\text{Mean Process Turnaround Time} = \frac{30+12+2+6+20}{5} = 14 \text{ minutes}$$

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**3: A soft real-time system has four periodic events with periods of 50, 100, 200, and 250 msec each. Suppose that the four events require 35, 20, 10, and x msec of CPU time, respectively. What is the largest value of x for which the system is schedulable?**

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**4: Consider the following state of a system with four processes, P1, P2, P3, and P4, and five types of resources, RS1, RS2, RS3, RS4, and RS5:**

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$$C = \begin{array}{|c|c|c|c|c|} \hline 0 & 1 & 1 & 1 & 2 \\ \hline 0 & 1 & 0 & 1 & 0 \\ \hline 0 & 0 & 0 & 0 & 1 \\ \hline 2 & 1 & 0 & 0 & 0 \\ \hline \end{array} \quad R = \begin{array}{|c|c|c|c|c|} \hline 1 & 1 & 0 & 2 & 1 \\ \hline 0 & 1 & 0 & 2 & 1 \\ \hline 0 & 2 & 0 & 3 & 1 \\ \hline 0 & 2 & 1 & 1 & 0 \\ \hline \end{array} \quad \begin{array}{l} E = (24144) \\ A = (01021) \end{array}$$

Using the deadlock detection algorithm described in Section 6.4.2, show that there is a deadlock in the system. Identify the processes that are deadlocked.

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5: A system has four processes and five allocable resources. The current and maximum needs are as follows:

	Allocated	Maximum	Available
Process A	1 0 2 1 1	1 1 2 1 2	0 0 x 1 1
Process B	2 0 1 1 0	2 2 2 1 0	
Process C	1 1 0 1 0	2 1 3 1 0	
Process D	1 1 1 1 0	1 1 2 2 1	

What is the smallest value of x for which this is a safe state? Show your calculations using the Banker's Algorithm.

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