CPEN 432: Homework Assignment 4

Deadline: 11:59 PM, 21 March, 2022

1 Stack Resource Policy [35 points]

1.1 Example [25 points]

Consider the example discussed in the class during Lecture 14, consisting of three tasks τ_1, τ_2, and τ_3, as summarized below (all time units are in milliseconds). The

τ_i	D_i	T_i	π_i	$\mu_i(R_1)$	$\mu_i(R_2)$	$\mu_i(R_3)$	a_i
τ_1	12	12	3	1	0	1	2.5
τ_1	15	15	2	2	1	3	1.5
τ_1	19	19	1	3	1	1	0

execution and resource access pattern of each task remains the same as in the example discussed in the class, *i.e.*, as shown in https://cpen432.github.io/resources/gujarati-slides/14-notes.pdf. In the class, we considered only the first job of each task. Suppose that these are periodic jobs with implicit deadlines, *i.e.*, $D_i = T_i$.

1. Illustrate the schedule from time $t = 0$ to time $t = 20$.
2. Show how the resource ceilings and the system ceiling vary in this duration.
3. Explain every instance of a failed or a successful preemption test.

Feel free to attach a spreadsheet containing the answers, if required.

1.2 Blocking Analysis [10 points]

Consider a periodic task set $\tau = \{\tau_1, \tau_2, \tau_3, \tau_4\}$ consisting of four tasks with three shared resources $\{R_1, R_2, R_3\}$, as summarized in the table below. The duration for which each resource is used by the tasks is specified in another table below. Assume that a task

Task	C_i	T_i	Resources used
τ_1	4	10	R_1, R_2
τ_2	5	20	R_2, R_3
τ_3	10	35	R_3
τ_4	2	40	R_1

Resource	Duration
R_1	2
R_2	1
R_3	2

locks only one resource at a time, *i.e.*, there are no nested critical sections. Assume *implicit* deadlines. Can task set τ be scheduled to meet deadlines using

1. RM with SRP?
2. EDF with SRP?

In each case, explain your answer (*i.e.*, show the analysis steps) and, if your answer is no, specify which tasks may miss their deadlines.

Note: For resource sharing protocols where the blocking time is bounded by the length of a single critical section, when computing the blocking time, one time unit is subtracted from the length of the critical section. For example, in Equations 7.4 and 7.16 in the textbook, $\delta_{j,k} - 1$ is used instead of just $\delta_{j,k}$.

2 Practical Considerations [15 points]

Compare and contrast the implementation effort needed for PIP, PCP, and SRP. Please keep your answers concise but informative. For reference, you may read through sections 7.6.4, 7.7.4, and 7.8.6 from the textbook on implementation considerations for these protocols.