CS 330 - Winter 2020
Assignment W3

Due: Monday, February 17, 2020 (start of class)

You should submit a physical copy of your written homework at the start of class. Be sure to include a collaboration statement with your assignment, even if you worked alone. This is worth 2 points.

[18 points] Problem 1 - Pi-Blocking

Create a task set of three tasks that can cause at least four time units of priority-inversion blocking for τ_1 and at least two units of priority-inversion blocking for τ_2, assuming none of the locking protocols we discussed are used, just a semaphore to protect each resource. State $(\Phi_i, T_i, C_i, \delta_{i,A})$ for each task and draw a schedule that produces the required priority inversions.

[40 points] Problem 2 - Blocking under each protocol

Consider the task set comprised of the following five tasks which share four resources (but assume there are no nested critical sections). The maximum duration of each critical section, $\delta_{i,k}$, is given in the table below for each task τ_i and resource ℓ_k.

	A	B	C	D
τ_1	4	0	3	0
τ_2	0	0	0	4
τ_3	2	9	3	0
τ_4	3	1	3	1
τ_5	7	0	0	2

a) What are γ_1, γ_2, γ_3, γ_4, and γ_5 for this task set, assuming the NPP is used? What are B_1, B_2, B_3, B_4, and B_5?

b) What are γ_1, γ_2, γ_3, γ_4, and γ_5 for this task set, assuming the HLP is used? What are B_1, B_2, B_3, B_4, and B_5?

c) What are γ_1, γ_2, γ_3, γ_4, and γ_5 for this task set, assuming the PIP is used? What are B_1, B_2, B_3, B_4, and B_5?

d) What are γ_1, γ_2, γ_3, γ_4, and γ_5 for this task set, assuming the PCP is used? What are B_1, B_2, B_3, B_4, and B_5?

[26 points] Problem 3 - RM with NPP

a) Consider the task set $\tau = \{\tau_1, \tau_2\} = \{(5, 2, 1), (7, 4, 3)\}$ in which each task is represented as $(T_i, C_i, \delta_{i,A})$. What are γ_1 and γ_2 for this task set, assuming NPP and RM scheduling? What are B_1 and B_2 for this task set?

b) For the task set in part (a), assume that both tasks always execute the non-resource-requiring work first, and then execute their work that requires access to Resource A (their critical section) after. Draw the schedule that is produced by these constraints from time $t = 0$ to time $t = 35$.

c) Again consider the task set from part (a). This time, assume that the critical section occurs first, followed by the non-resource-requiring work. Draw the schedule that is produced by these constraints for $t = 0$ to $t = 35$.

d) Conduct the modified response-time analysis (aka TDA) test for both tasks in the presence of blocking. Can we guarantee that this task set is schedulable by RM?

[14 points] Problem 4 - RM with HLP

Consider the task set $\tau = \{\tau_1, \tau_2, \tau_3\} = \{(9, 4, 1), (25, 6, 3), (30, 5, 2)\}$ in which each task is represented as $(T_i, C_i, \delta_{i,A})$.

a) What are γ_1, γ_2, and γ_3 for this task set, assuming RM scheduling with the HLP? What are B_1, B_2, and B_3?

b) Conduct the modified RM utilization test for all tasks. Can we guarantee that this task set is schedulable by RM?