CS 330 - Winter 2025
Assignment W4

Due: Wednesday, February 5, 2025 (start of class)

You should submit a physical copy of your written homework at the start of class.

[2 points] Collaboration Statement

Be sure to include a collaboration statement with your assignment, even if you worked alone.

[30 points] Problem 1 - DM

a) Consider the following task set:

$$\tau = \{(T_i, C_i, D_i)\} = \{(8, 2, 6), (16, 7, 15), (24, 4, 20), (48, 2, 40)\}.$$

Use Response-Time Analysis (see page 96 of Buttazzo for a listing of the algorithm) to show that task τ_3 meets its deadlines under Deadline-Monotonic scheduling. Make sure to show your work, including the values of $R_3^{(k)}$ and $I_3^{(k)}$ for each iteration k.

b) Draw the RTA graph for task τ_3 lined up with the schedule for times $t = 0$ to $t = 20$. This should look like Figure 4.16 on Buttazzo page 95. Make sure to include release and deadline arrows, and completion hats. (Note that Buttazzo doesn't include completion hats and draws releases as vertical bars, but you should have them.)

c) Perform RTA again for task τ_3 assuming that the worst-case execution time of task τ_2 is increased to 9, i.e., that $C_2 = 9$. (You do not have to re-draw the schedule or RTA graph.)

[18 points] Problem 2: Cyclic Executive

Read Buttazzo Section 4.2, which is two pages talking about Cyclic Executive (a.k.a. Timeline Scheduling). This approach statically lists a sequence of tasks to execute each minor cycle, guaranteeing that deadlines will be met in doing so.

There are three rules that must be satisfied when determining the time-slice duration (a.k.a. "minor cycle" or "frame size") for a given task set. Let's call the time-slice duration f. We require that (1) the time slice can't be less than any task's WCET, (2) f divides the hyperiod H, which must be a multiple of each T_i, and (3) there is at least one full frame between the release time and deadline of each job. Thus, where gcd() represents the greatest common divisor, we have:

1. $\forall i : f \geq C_i$
2. $\exists i : f$ divides T_i
3. $\forall i : 2f - \gcd(T_i, f) \leq D_i$

a) Consider the following task system, in which $\tau_i = (T_i, C_i, D_i)$. What are the frame size f and the major cycle (a.k.a. hyperiod) H?

$$\tau = \{\tau_1, \tau_2, \tau_3\} = \{\ (16, 4, 16),\ (24, 10, 24),\ (48, 8, 40)\ \}$$

b) Give an allocation of each job in the major frame to specific frames. For example, perhaps jobs $J_{1,1}$ and $J_{3,1}$ are allocated to frame 1, jobs $J_{1,2}$ and $J_{2,1}$ to frame 2, etc. (Recall that $J_{i,j}$ denotes the jth job of task τ_i.) You can sketch out the major frame or list out the jobs; it should be similar in concept to Fig. 4.4 on Buttazzo page 74.