CSIE 5452, Fall 2019 — Homework 1

Due October 7 (Monday) at Noon

When you submit your homework on Gradescope, please select the corresponding page(s) of each problem. Points may be deducted if no appropriate intermediate step is provided.

1 Timing Analysis of the CAN Protocol — Part I (20pts)

Given a set of periodic messages μ_0, μ_1, μ_2 with their priorities, transmission times, and periods as follows:

Message	Priority (P_i)	Transmission Time (C_i) (msec)	Period (T_i) (msec)
μ_0	0	10	50
μ_1	1	30	200
μ_2	2	20	100

The worst-case response time R_i of μ_i can be computed as

$$R_i = Q_i + C_i, \tag{1}$$

and

$$Q_i = B_i + \sum_{\forall j, P_j < P_i} \left\lceil \frac{Q_i + \tau}{T_j} \right\rceil C_j, \tag{2}$$

where $\tau = 0.1$ in this question. You can consider using the following tables to help you.

1. (4pts) What is the worst-case response time of μ_0? 30+10=40

Iteration	LHS (Q_0)	B_0	RHS	Stop?
1	30	30	30	Yes

2. (8pts) What is the worst-case response time of μ_1? 40+30=70

Iteration	LHS (Q_1)	B_1	j	$Q_1 + \tau$	T_j	$\left\lceil \frac{Q_1 + \tau}{T_j} \right\rceil$	C_j	RHS	Stop?
1	30	30	0	30.1	50	1	10	40	No
2	40	30	0	40.1	50	1	10	40	Yes
3			0						

3. (8pts) What is the worst-case response time of μ_2? 70+20=90

Iteration	LHS (Q_2)	B_2	j	$Q_2+\tau$	T_j	$\lceil \frac{Q_2+\tau}{T_j} \rceil$	C_j	RHS	Stop?
1	20	20	0 1	20.1	50 200	1 1	10 30	60	No
2	60	20	0 1	60.1	50 200	2 1	10 30	70	No
3	70	20	0 1	70.1	50 200	2 1	10 30	70	Yes

2 Timing Analysis of the CAN Protocol — Part II (34pts)

Please download the benchmark "Input.dat" from NTU COOL. In the benchmark, the first number is n, the number of messages. The second number is τ. Each of the following lines contains the priority (P_i), the transmission time (C_i), and the period (T_i) of each message. You are required to do two things in your submission:

1. You should print out n numbers (one number per line) representing the worst-case response time (R_i) of those messages. Note that you need to follow the message ordering in the benchmark, *e.g.*, the first number in the list is the worst-case response time of the first message in the benchmark.
2. You should also print out your source codes. (For your information, my implementation is less than 100 lines.) We may ask you to provide your source codes which must be the same as those on your printout. If the worst-case response times above are correct but the source codes are clearly wrong implementation, it is regarded as academic dishonesty.

It is highly recommended to write your codes well (*e.g.*, capable of dynamically allocating memory based on n) so that you can reuse them in Homework 2 or Homework 3. Ideally, you can test your implementation with the small benchmark in Question 1 and verify its solution by your implementation. Just do not make the same mistake in Questions 1 and 2.

3 Timing Analysis of TDMA-Based Protocols (16pts)

Following the assumptions (each time slot has the same length, each time slot serves exactly one frame, and a frame is transmitted only if the whole time slot is available) in the lecture, please compute the worst-case response time of the "asynchronous" message with the frame arrival pattern $(4, 10, 0, 3, 5, 6)$ and the schedule pattern $(2, 5, 1, 2)$ by completing the following steps.

1. (2pts) Please duplicate the schedule pattern (hint: $(4, 10, 1, 2, \ldots)$). No intermediate work is needed here. (4, 10, 1, 2, 6, 7)
2. (2pts) Please duplicate the arriving times of frames in the frame arrival pattern but fix $m = 4$ and $p = 10$. No intermediate work is needed here. (4, 10, 0, 3, 5, 6, 10, 13, 15, 16)
3. (2pts) Please duplicate the starting times of time slots in the schedule pattern but fix $n = 4$ and $q = 10$. No intermediate work is needed here. (4, 10, 1, 2, 6, 7, 11, 12, 16, 17)
4. (8pts) Please complete the following table:

k	$\max_{1\le j\le n}(s_{j+k}-s_j)$	$=$	$\min_{1\le i\le m}(a_{i+k-1}-a_i)$	$=$	(Column-3) $-$ (Column-5)
1	$\max_{1\le j\le 4}(s_{j+1}-s_j)$	4	$\min_{1\le i\le 4}(a_i-a_i)$	0	4
2	$\max_{1\le j\le 4}(s_{j+2}-s_j)$	5	$\min_{1\le i\le 4}(a_{i+1}-a_i)$	1	4
3	$\max_{1\le j\le 4}(s_{j+3}-s_j)$	9	$\min_{1\le i\le 4}(a_{i+2}-a_i)$	3	6
4	$\max_{1\le j\le 4}(s_{j+4}-s_j)$	10	$\min_{1\le i\le 4}(a_{i+3}-a_i)$	6	4

5. (2pts) Please compute the worst-case response time (which is waiting time plus transmission time) of the message. max -> 6
   6+1 = 7