Solution to EE 4770 1998 Homework 5

Problem 1: Event and handler information from problem:

Event Name	Strong Prior.	Weak Prior.	Handler Run Time	Event Timing
A	3	2	$5\,\mu$s	Periodic, $15\,\mu$s
B	3	1	$4\,\mu$s	Periodic, $22\,\mu$s
C	2	2	$(28+2c)\,\mu$s	Periodic, $100\,\mu$s
D	2	1	$400\,\mu$s	Periodic, 1 ms
E	1	1	60 ms	At initialization and 50 ms after each response.

Solution:

Event	Load Set	Load Fact.	Loaded Dur.	Latency	Run	Response	Load
A	$\emptyset$	1	$5\,\mu$s	$4\,\mu$s	$5\,\mu$s	$9\,\mu$s	0.3333
B	$\emptyset$	1	$4\,\mu$s	$5\,\mu$s	$4\,\mu$s	$9\,\mu$s	0.1818
C	$\emptyset$	1	$(28+2c)\,\mu$s	$834\,\mu$s	$103\,\mu$s	$928\,\mu$s	0.0760
D	$\{A,B\}$	0.485	$825\,\mu$s	$71\,\mu$s	$825\,\mu$s	$896\,\mu$s	0.4000
E	$\{A,B,C,D\}$	0.008848	6.7808 s	$928\,\mu$s	6.7808 s	6.7818 s	0.0088
						Total Load:	0.9999

Events A and B, sharing the highest strong priority level can only delay each other and at most for one run. (That is, event A never has to wait for 2 B's, and vice versa.) To find the latency, run time, and response time of A use event sequence B,A. To find the latency, run time, and response time of B use event sequence A,B.

Latency, run time, and response time of D.

The run time of the handler for event D is more than $50\times$ A or B's handler, so D's load set includes these events, the loaded duration is $825\,\mu$s. C runs during D's worst-case latency, the event sequence is:
Event Sequence: $C, D, A_0, B_0, A_1, B_1, A_2, B_2, A_3, A_4, B_3$

The handler for D starts when C finishes at $71\,\mu$s; D finishes at $896\,\mu$s (based on its loaded duration). (Only A and B can interrupt D, since they are included in the loaded duration nothing else is needed to find the run time and response time.)

Latency, run time, and response time of C.

Event C's worst-case latency is encountered when it occurs just after D and then also must wait for A and B (not including the ones occurring during D). The event sequence is:
Event Sequence: D, C, A, B

The handler for C starts at $834\,\mu$s. The worst case run time starts with the same event sequence, but A and B occur after C has started. At the time C starts there will have been 9 occurrences of C in the $825\,\mu$s or $834\,\mu$s since D started. From the time D finishes to the time C finishes event A will occur 7 times, event B 5 times, and event C will occur one more time. The handler for C will then finish $103\,\mu$s after D finishes. When the first A and B occur after C starts that gives a worst-case run time of $103\,\mu$s. Either way, the worst-case response time is $928\,\mu$s.

Latency, run time, and response time of E.

All events load E. Computation of the loading factor is straightforward for all events but C, which does not have a fixed execution time. To find an average run time for C, note its relationship with D. Event D occurs every millisecond, every millisecond 10 Cs occur. Depending on timing all 10 of C's events could be handled by one run of the handler (when C occurs soon after D starts) or by two runs of the handler (when C occurs just before D starts). The latter case would put a heavier load on the system, $((28+2)+(28+9\times 2))/1000$. Using this higher load, the loading factor for E is 0.0088, the latency, run time, and response time are $928\,\mu$s, 6.7808 s, 6.7818 s. (The latency is based on the response time of D.) The load imposed by E is its run time divided by its smallest period: its run time plus 50 ms. The load is 0.0088. The total load on the system is 0.9999, which only an accountant can love.