STUDY GUIDE

1- Review 2 previous study guides.

2- A system has 4 tasks, $T_1 = (11, 2.5)$, $T_2 = (18, 3)$ $T_3 = (33, 4)$ and $T_4 = (54, 4)$. Every third job of T_1 and T_2 releases T_3 and T_4 respectively. T_1 and T_2 suffer release-time jitter of 1ms and T_2 self-suspends 1-3 ms before releasing T_4. T_3 self suspends twice for a total of 4ms.

(a) What is the release-time jitter of T_3 and T_4.

ANS $r_3^+ - r_3^- = \boxed{1}$ (release-time jitter of T_1)

$r_4^+ - r_4^- = 1 + 2 = \boxed{3}$ (release time jitter of T_2 plus self-suspension range $(3-1)$)

b) Find the blocking times $b_i(ss)$ due to self-suspension.

ANS $x_1 = 1$ $\quad b_1(ss) = \boxed{1}$

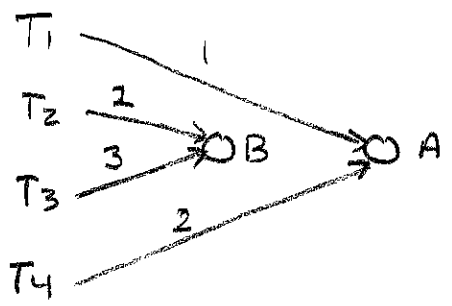
$x_2 = 1 + 3 = 4$ $\quad b_2(ss) = 4 + \min(2.5, 1) = \boxed{5}$

$x_3 = 1 + 4 = 5$ $\quad b_3(ss) = 5 + 1 + \min(3, 4) = \boxed{9}$

$x_4 = 3$ $\quad b_4(ss) = 3 + 1 + 3 + \min(4, 5) = \boxed{11}$

c) Suppose T_1 takes Resource A for 1ms and T_4 takes resource A for 2 ms. Also suppose T_2 and T_3 contend for B. Both hold B for 2ms of execution time, but T_3 self suspends 1ms while it holds B. Draw a resource requirement graph.

ANS



d) Assume one of the ceiling priority protocols is used, find direct & inheritance blocking tables.

ANS

Direct

	T_2	T_3	T_4
T_1	0	0	2
T_2	—	3	0
T_3	—	—	0

Inheritance

	T_2	T_3	T_4
T_1	0	0	0
T_2	—	0	2
T_3	—	—	2

e) find blocking times due to resource contention. ($b_i(rc)$)

ANS $b_1(rc) = \boxed{2}$

$b_2(rc) = \boxed{3}$

$b_3(rc) = \boxed{2}$

$b_4(rc) = \boxed{0}$

} Maximum from all columns of both tables

f) Suppose the longest non preemptive critical section in tasks that take resource B (T_2, T_3) is 0.2ms, and the longest critical section in the other tasks (T_1, T_4) is 0.1 ms. Find the blocking time due to non-preemptive critical sections ($b_i(np)$)

ANS $b_1(np) = \boxed{0.2\text{ ms}}$ (T_2 & T_3 may block 0.2ms)

$b_2(np) = \boxed{0.2\text{ ms}}$ (T_3 may block 0.2ms)

$b_3(np) = \boxed{0.1\text{ ms}}$ (T_4 may block 0.1ms)

$b_4(np) = \boxed{0}$

g) find the total blocking times for the tasks

ANS $b_1 = 1 + 2 + 0.2(1+0) = \boxed{3.2}$ $(K_1 = 0)$

$b_2 = 5 + 3 + 0.2(1+1) = \boxed{8.4}$ $(K_2 = 1)$

$b_3 = 9 + 2 + 0.1(1+2) = \boxed{11.3}$ $(K_3 = 2)$

$b_4 = \boxed{3\ ms}$

h) Assume context switch overhead is 0.05 ms,

ANS find the effective execution times.

$e_1 = 2.5 \quad 2(0.05)(1+1) = \boxed{2.7}$ (resource)

$e_2 = 3 + 2(0.05)(1+1+1) = \boxed{3.3}$ (resource, $K_2 = 1$)

$e_3 = 4 + 2(0.05)(1+1+2) = \boxed{4.4}$ (resource, $K_3 = 2$)

$e_4 = \boxed{4.}$

i) Find time demand functions $W_i(t)$

ANS $W_1(t) = 2.7 + 3.2 = 5.9$

$W_2(t) = 3.3 + 8.4 + 2.7\left\lceil \frac{t}{11} \right\rceil = 11.7 + 2.7\left\lceil \frac{t}{11} \right\rceil$

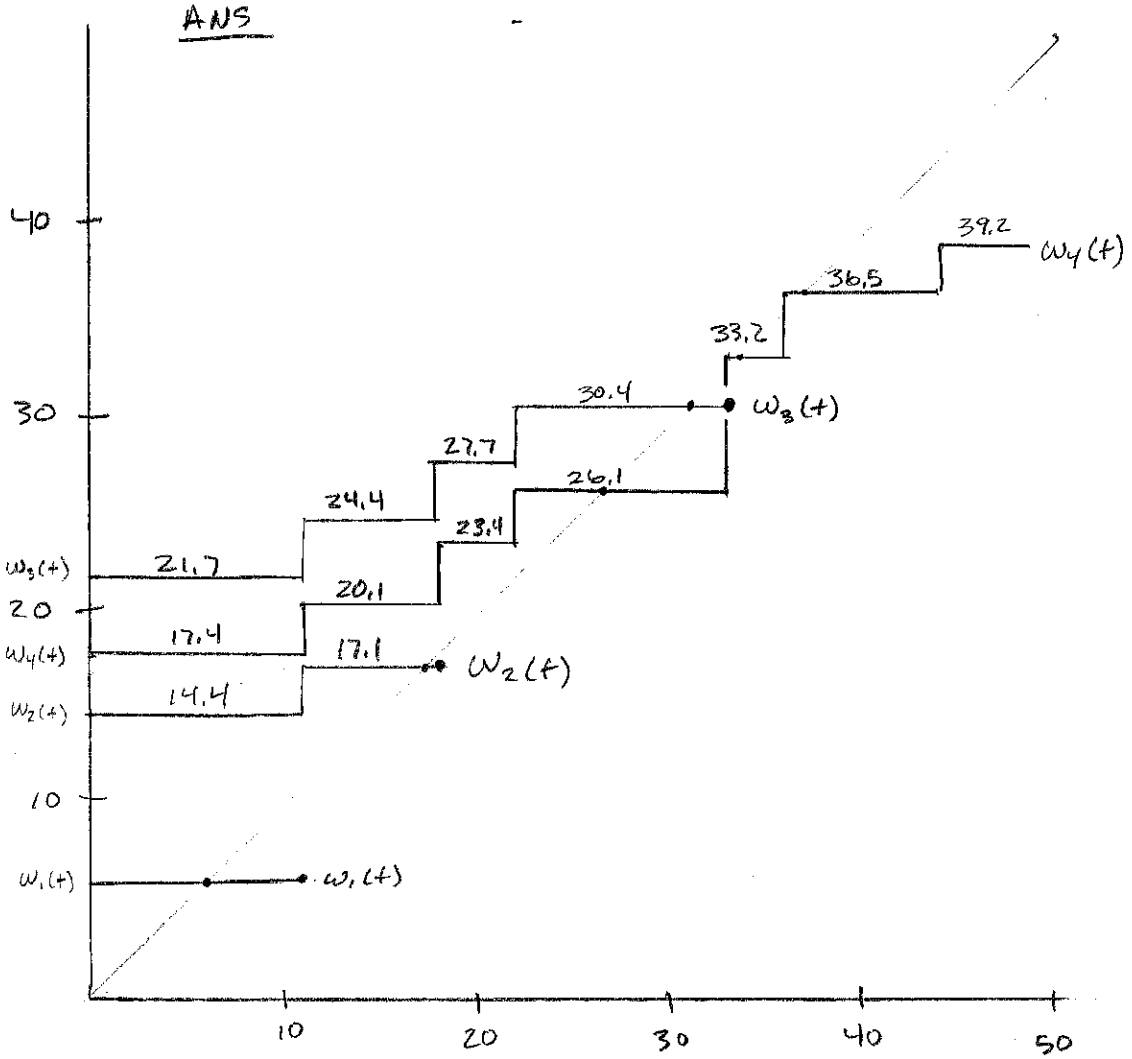
$W_3(t) = 4.4 + 11.3 + 2.7\left\lceil \frac{t}{11} \right\rceil + 3.3\left\lceil \frac{t}{18} \right\rceil$

$= 15.7 + 2.7\left\lceil \frac{t}{11} \right\rceil + 3.3\left\lceil \frac{t}{18} \right\rceil$

$W_4(t) = 7 + 2.7\left\lceil \frac{t}{11} \right\rceil + 3.3\left\lceil \frac{t}{18} \right\rceil + 4.4\left\lceil \frac{t}{33} \right\rceil$

3. Determine whether or not these tasks are schedulable.

ANS



All tasks can be scheduled.

3- The following tasks need to be scheduled on a multi-processor system $T_1 = (5, 1)$, $T_2 = (8, 1)$ $T_3 = (11, 4)$, $T_4 = (15, 4)$, $T_5 = (21, 9)$, $T_6 = (24, 7)$ $T_7 = (30, 6)$, $T_8 = (48, 22)$.

(a) Assign these tasks to processors using RMFF

ANS

$T_1 \rightarrow P_1$

$T_2 \rightarrow P_1$ ($1/5 + 1/8 = 0.325 < 0.828 \rightarrow$ ok for P1)

$T_3 \rightarrow P_1$ ($1/5 + 1/8 + 4/11 \approx 0.688 < 0.778 \rightarrow$ ok for P1)

$T_4 \rightarrow P_2$ ($1/5 + 1/8 + 4/11 + 4/15 \approx 0.955 > 0.757 \rightarrow$ Not P1)

$T_5 \rightarrow P_2$ ($1/5 + 1/8 + 4/11 + 9/21 \approx 1.117 > 0.757 \rightarrow$ Not P1)

($4/15 + 9/21 \approx 0.695 < 0.828 \rightarrow$ ok for P2)

$T_6 \rightarrow P_3$ (won't fit on P_1 or P_2)

$T_7 \rightarrow P_3$ (won't fit on P_1 or P_2)

($7/24 + 6/30 \approx 0.492 < 0.828 \rightarrow$ ok for P_3)

$T_8 \rightarrow P_4$ ($7/24 + 6/30 + 22/48 \approx 0.950 > 0.757 \rightarrow$ Not for P_3)

b) What is the utilization of the processors in part (a)

ANS

$U_1 = 0.688$

$U_2 = 0.695$

$U_3 = 0.492$

$U_4 = 0.458$

c) Group simple periodic tasks and reassign tasks to processors.

ANS

Group1 = (T_1, T_4, T_7) - periods = 5, 15, 30,

Utilization = $1/5 + 4/15 + 6/30 = 0.667$

Group2 = (T_2, T_6, T_8) - periods = 8, 24, 48

Utilization = $1/8 + 7/24 + 22/48 = 0.875$

Group3 = (T_3) - utilization = $4/11 = 0.364$

Group4 = (T_5) - utilization = $9/21 = 0.429$

ANS (cont.)

Group 1 → P_1

Group 2 → P_2 $(0.667 + 0.875 > 0.828 \rightarrow$ not $P_1)$

Group 3 → P_3 $(0.667 + 0.364 > 0.828 \rightarrow$ not $P_1)$

$(0.875 + 0.364 > 0.828 \rightarrow$ not $P_2)$

Group 4 → P_3 $(0.364 + 0.429 = 0.793 < 0.828)$

d) What is the utilization of the processors in part (c)?

ANS $U_1 = 0.667$, $U_2 = 0.875$, $U_3 = 0.793$.

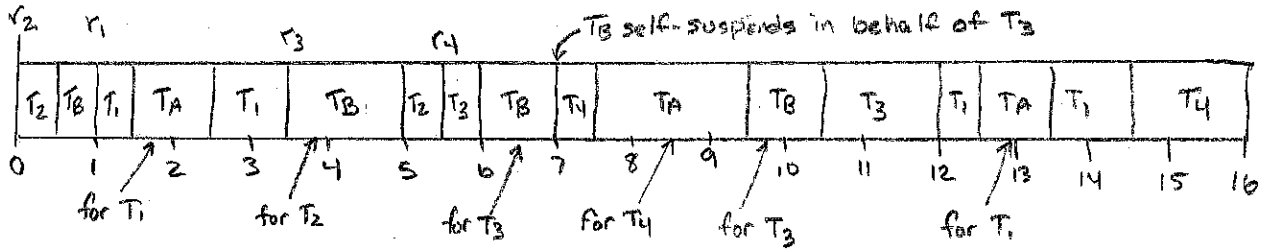
4- Suppose server tasks T_A and T_B are used to control access to resources A and B in Problem 2.

a) What priority should T_A and T_B be?

ANS $T_A = \pi_1$, $T_B = \pi_2$

b) Assume each task takes its resource 0.5 ms after beginning execution, neglect context switch overhead and non-preemptive critical sections, Assume only T_3 self suspends, and for only 1 ms while holding B. $r_1 = 1$, $r_2 = 0$, $r_3 = C_1$, $r_4 = C_2$ where C_1 & C_2 are the completion times of T_1 and T_2. Show the ceiling priority schedule.

ANS



Note: T_B is ready to run at $t = 8$, but T_A has priority.

c) Assume T_1, T_B and T_3 are assigned to P_1 and T_2, T_A and T_4 are assigned to P_2. Assign task priorities as for the ceiling priority protocol. Schedule these tasks under the conditions in part (b).

ANS