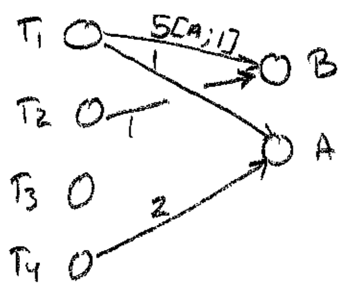
EE 4710 Study Guide

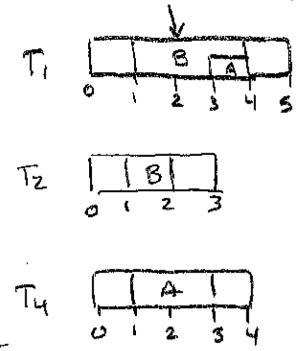
1. A system has 4 tasks $T_1 = (2, 12, 5; [B; 3[A; 1]])$
   T_1 executes 1ms then takes B, executes 1 more 1ms then self-suspends 2ms. It then executes 1ms and takes A. after 1 more ms it releases A and B. Finally it executes 1 more ms and terminates. $T_2 = (3, 20, 3; [B; 1])$, $T_3 = (4, 25, 2)$ and $T_4 = (0, 30, 4; [A; 2])$. T_2 and T_4 execute 1ms before and after taking the resource

   a) Draw a resource requirement graph

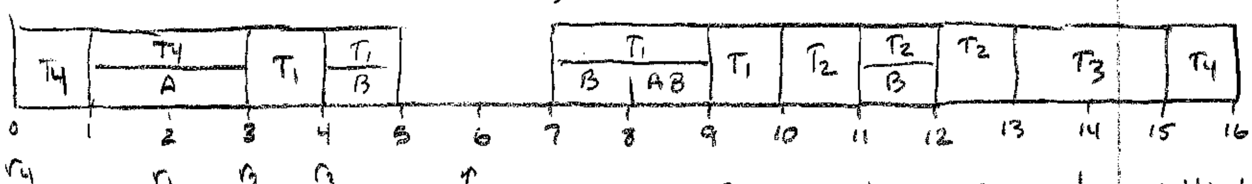


Self suspends 2ms

Not Req'd

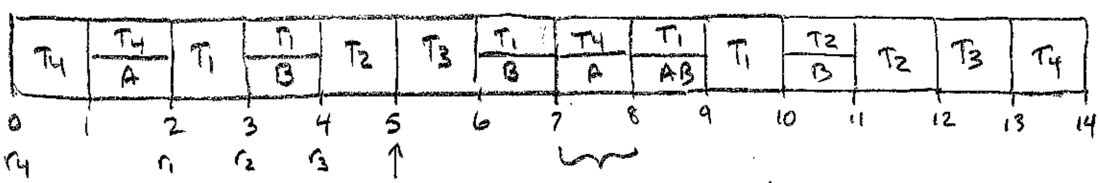


   b) Schedule these tasks using NPCS protocol



Should never self-suspend in non-preemptive critical section.

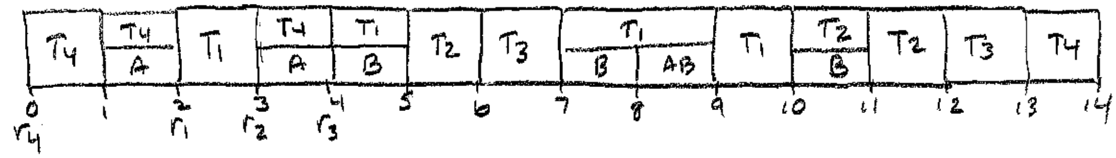
   c) Schedule these tasks using Priority inheritance protocol

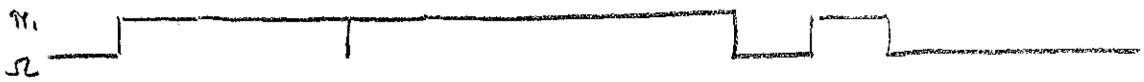


T_2 cannot continue because T_1 holds B

T_4 promoted to π_1

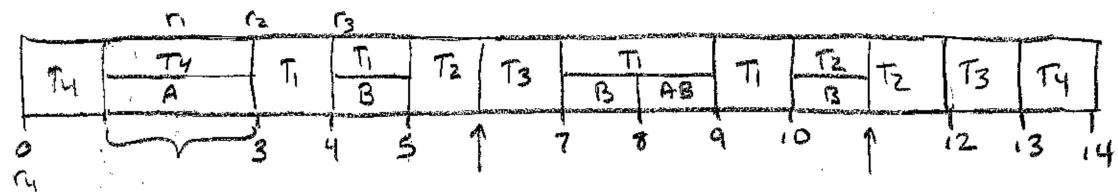
d) Schedule these tasks using the Priority Ceiling Protocol
Also plot $\hat{\Pi}(t)$





e) Schedule these tasks using ceiling priority protocol

$\Pi(A) = \Pi_1 \qquad \Pi(B) = \Pi_1$



T_4 running at Π_1

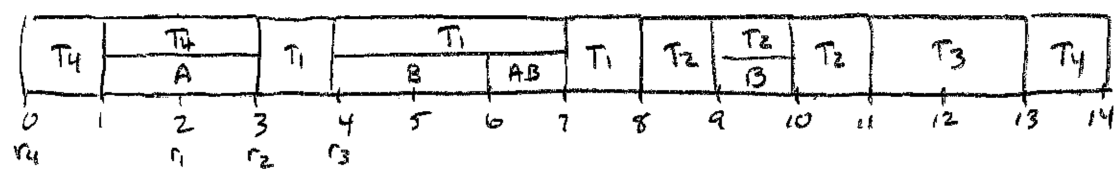
T_2 promoted to Π_1, must wait for T_1 to finish (FIFO)

T_2 returns to Π_2 but still highest priority

f) Can these tasks be scheduled using stack based PCP? Why.

A: No, Task 1 self suspends.

g) Assume Task 1 does not self-suspend. Schedule these tasks using stack based Priority Ceiling Protocol, Plot $\hat{\Pi}(t)$



2. A system has 4 tasks. $T_1 = (15, 3; [X; 1])$, $T_2 = (25, 2)$, $T_3 = (30, 7; [X; 5 [Y; 3]])$ and $T_4 = (50, 12; [Y; 3] [X; 7])$

T_1 self suspends once for 1ms but not while X is held

T_2 self suspends twice for a total of 3 ms

T_3 self suspends once for 1ms while holding X but not Y

a) Find the blocking time due to self suspension $b_i(ss)$ for each task

$x_1 = 1$, $x_2 = 3$, $x_3 = 1$, $x_4 = 0$

$b_1(ss) = x_1 = 1$

$b_2(ss) = x_2 + \min(x_1, e_1) = 3 + 1 = 4$

$b_3(ss) = x_3 + \min(x_1, e_1) + \min(x_2, e_2) = 1 + 1 + 2 = 4$

$b_4(ss) = x_4 + \min(x_1, e_1) + \min(x_2, e_2) + \min(x_3, e_3) = 0 + 1 + 2 + 1 = 4$

b) Suppose T_1 has a non-preemptive critical section of 0.5ms, T_2 has 2 sections of 0.3ms and 0.4ms. T_3 has a 0.2 ms critical section and T4 has 3 critical sections 0.1 ms each. Find blocking time due to the worst case non-preemptive critical sections.

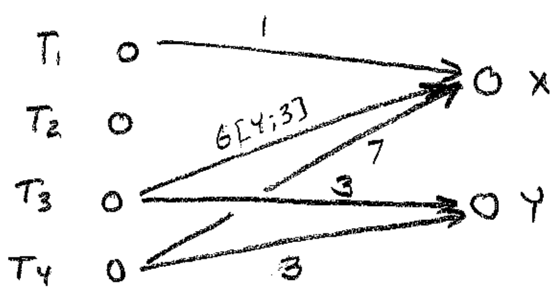
$b_1(np) = \max(0.3, 0.4, 0.2, 0.1, 0.1, 0.1) = 0.4$

$b_2(np) = \max(0.2, 0.1, 0.1, 0.1) = 0.2$

$b_3(np) = \max(0.1, 0.1, 0.1) = 0.1$

$b_4(np) = 0$

c) Draw a resource requirement graph for this system



Remember T_3 self-suspends while holding X

d) Create direct and inheritance blocking tables for this system

Direct:

	T_2	T_3	T_4
T_1	0	6	9
T_2	-	0	0
T_3	-	-	7

Note that for *some* protocols and this particular system, it would be impossible for T_1 to wait for both T_3 *and* T_4 because $\Pi(X) = \Pi(Y) = \pi_1$ but on the exam do not use that fact. Compute blocking times for the worst case.

Inheritance:

	T_2	T_3	T_4
T_1	0	0	0
T_2	-	5	9
T_3	-	-	7

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

$b_1(rc) = \max(5, 9) = 9$

$b_2(rc) = \max(5, 9) = 9$

$b_3(rc) = \max(7, 7) = 7$

$b_4(rc) = 0$

f) Assume context switch time is 0.1 ms. Find the effective execution time for each task. Assume PCP.

# of self suspensions: $k_1 = 1$, $k_2 = 2$, $k_3 = 1$

$e_1 = 3 + 2(2 + k_1)(0.1) = 3.6$ (Takes a resource)

$e_2 = 2 + 2(1 + k_2)(0.1) = 2.6$ (no resource)

$e_3 = 7 + 2(2 + k_3)(0.1) = 7.6$

$e_4 = 12$

g) Find the total blocking time, b_i

$b_1 = b_1(ss) + (1 + k_1) b_1(np) + b_1(rc) = 1 + 2(0.4) + 9 = 10.8$

$b_2 = b_2(ss) + (1 + k_2) b_2(np) + b_2(rc) = 4 + 3(0.2) + 9 = 13.6$

$b_3 = b_3(ss) + (1 + k_3) b_3(np) + b_3(rc) = 4 + 2(0.1) + 7 = 11.2$

$b_4 = b_4(ss) = 4$

h) Find the time demand functions $w_i(t)$

$$w_1(t) = b_1 + e_1 = 10.8 + 3.6 = 14.4$$

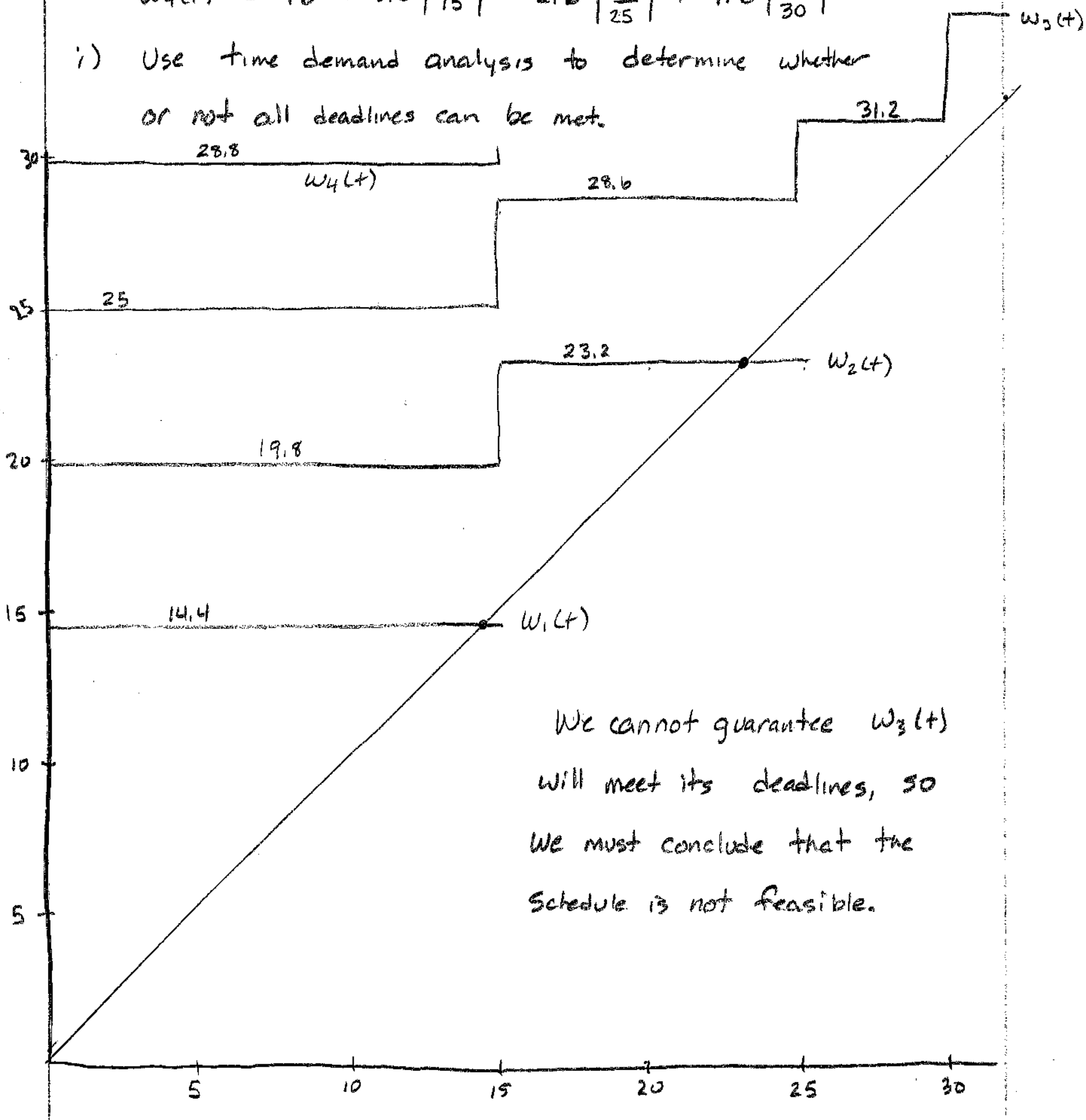
$$w_2(t) = b_2 + e_2 + \left\lceil \frac{t}{p_1} \right\rceil e_1 = 13.6 + 2.6 + \left\lceil \frac{t}{15} \right\rceil 3.6$$

$$= 16.2 + 3.6 \left\lceil \frac{t}{15} \right\rceil$$

$$w_3(t) = 18.8 + 3.6 \left\lceil \frac{t}{15} \right\rceil + 2.6 \left\lceil \frac{t}{25} \right\rceil$$

$$w_4(t) = 16 + 3.6 \left\lceil \frac{t}{15} \right\rceil + 2.6 \left\lceil \frac{t}{25} \right\rceil + 7.6 \left\lceil \frac{t}{30} \right\rceil$$

i) Use time demand analysis to determine whether or not all deadlines can be met.



We cannot guarantee $w_3(t)$ will meet its deadlines, so we must conclude that the schedule is not feasible.