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ENEL 452 Assignment 3 Mubashir Hussain

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1.) Tasks ⇒ 1 2 3

	1	2	3
	10ms	39ms	1000ms
WCET	4ms	12ms	98ms

$$u = \frac{4}{10} + \frac{12}{39} + \frac{98}{1000} \Rightarrow 0.384 \Rightarrow 38.4\%$$

not feasible unless:

$$u \leq n(2^{1/n} - 1) \Rightarrow u \leq 3(2^{1/3} - 1) \Rightarrow 77.9\%$$

- This is not feasible because the tasks are not harmonics relative to eachother.
- To change it to guarantee feasability you change the task 2 execution time to 40ms.

/20 2.)

Task	Cycle (ms)	Execution time (ms)	Priority (highest)
A	10	4	3
B	20	5	1
C	40	10	2
Idle	continous	5	—

a) i) $u = \frac{4}{10} + \frac{5}{20} + \frac{10}{40} \Rightarrow 0.90 = 90\%$

ii) Not harmonic. $u \leq 4(2^{1/4} - 1) \Rightarrow 0.7568 \Rightarrow 75.7\%$

$90\% \leq 75.7 \Rightarrow$ false so not a feasible RMS schedule.

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iii) Response time for each tasks

tasks: A (P_0 = 10, C_0 = 4, deadline = 10) B(20,5,20), C(40,10,40)

$$R_i = C_i + \sum_{\forall j \in hp(i)} \left\lceil \frac{R_i}{P_j} \right\rceil C_j$$

unknowns: R_A R_B R_C

Recursion Relation: $R_i^{k+1} = C_i + \sum_{\forall j \in hp(i)} \left\lceil \frac{R_i^k}{P_j} \right\rceil C_j$ (ceiling function)

	A (ms)	B (ms)	C (ms)
Known:	$C_A = 4$	$C_B = 5$	$C_C = 10$
	$P_A = 10$	$P_B = 20$	$P_C = 40$
	$hp = \{\}$	$hp = \{C, A\}$	$hp = \{A\}$

find R_A ⇒ guess $R_0^0 = 0$

iteration 1: $R_A^1 = C_A + \sum_{j \in \{\}} \left\lceil \frac{0}{\cdot} \right\rceil C_j \Rightarrow \boxed{C_A = 4ms}$

find R_B ⇒ guess $R_B^0 = 0$

iteration 1: $R_B^1 = C_B + \sum_{j \in (C,A)} \left\lceil \frac{R_B^0}{P_j} \right\rceil C_j \Rightarrow \boxed{C_B = 5ms}$

use R_B^1 for better estimate.

iteration 2: $R_B^2 = C_B + \sum_{j \in (A,C)} \left\lceil \frac{R_B^1}{P_j} \right\rceil C_j$

$= 5ms + \left[\left(\frac{5ms}{10ms}\right)(4ms) + \left(\frac{5ms}{40ms}\right)(10ms)\right]$

$= 5ms + \text{ceiling}[3.25ms]$

$\Rightarrow (5 + 4)\,ms$

$\Rightarrow \boxed{9\,ms}$

iteration 3: $R_B^3 = C_B + \sum_{j \in (A,C)} \left[\frac{R_B^2}{P_j}\right] C_j$

$R_B^3 = C_B + \left[\left(\frac{9ms}{10ms}\right)(4ms) + \left(\frac{9ms}{40ms}\right)(10ms)\right]$

$\Rightarrow 5ms + \text{ceiling}[5.85ms]$

$\Rightarrow (5+6)ms$

$\Rightarrow \boxed{11ms}$

iteration 4:

$R_B^4 = C_B + \left[\frac{11ms}{10ms} \times 4ms + \frac{11ms}{40ms} \times 10ms\right]$

$= 5ms + \text{ceiling}[7.15] \Rightarrow (13ms)$

iteration 5:

$R_B^5 = 5m + \left[\frac{13ms}{10ms} \times 4ms + \frac{13ms}{40ms}(10ms)\right]$

$= \boxed{14ms}$

iteration 6: $R_B^6 = 5 + [9.1] \Rightarrow (15ms)$

$R_B^7 \Rightarrow 5 + [9.75] \Rightarrow (15ms)$ converges!

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find R_C $\Rightarrow$ guess $R_C^0 = 0$

iteration 1: $R_C^0 = C_C + \sum_{j \in \{A\}} \left[\frac{1}{\infty}\right] \Rightarrow C_C = 10ms$

iteration 2: $R_C^1 = 10ms + \left[\frac{10ms}{10ms} \times 4ms\right] = 10ms + \text{ceil}[4ms]$

$= \boxed{14ms}$

iteration 3: $R_C^2 = 10ms + \left[\left(\frac{14}{10} \times 4\right)ms\right] \Rightarrow 10 + \text{ceil}[5.6]$

$= \boxed{16ms}$

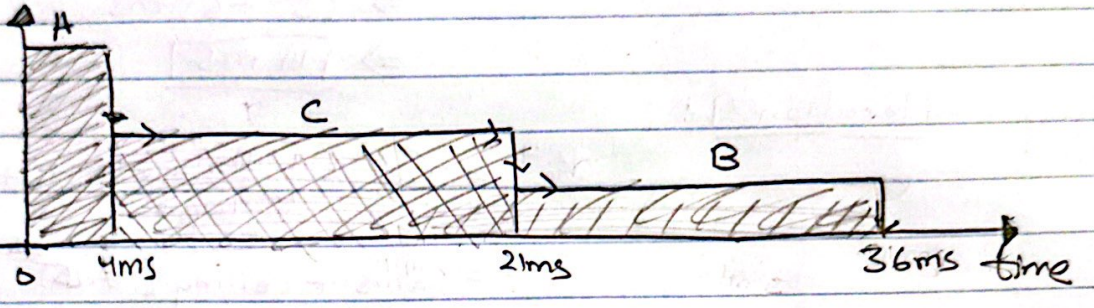
iteration 4: $R_C^3 = 10ms + \text{ceil}\left[\frac{16}{10} \times 4\right] \Rightarrow 10 + 7 = \boxed{17ms}$

iteration 5: $R_C^4 = 10 + \left[\frac{17}{10} \times 4\right] \Rightarrow \boxed{17ms}$

converges

iv)

task	Response	deadline	Result
A	4ms	10 ms	Beat by 6ms,
B	15 ms	20ms	Beat by -5ms
C	17ms	40	Beat by 23ms,
Idle			



b) i) same utilization ⇒ 90%

task	cycle (ms)	exec time (ms	Priority
A	10	4	3 (high)
B	20	5	2
C	40	10	1 (low)

ii) R_A ⇒ gues $R_A^0 = 0$

$$R_A^0 = C_A + \sum_{\forall j \in \{\}} \frac{R_A^0}{P_j} C_j = C_A = \boxed{4\,ms}$$

R_B ⇒ guess $R_B^0 = 0$

ceiling function

$$R_{B_0}^0 = C_B + \sum_{\forall \{A\}} \left[\frac{R_B^0}{P_A}\right] C_A \Rightarrow C_B = (5\,ms)$$

$$R_B^1 = C_B + \left[\frac{5\,ms}{10\,ms} \times 4\,ms\right] \Rightarrow 5\,ms + [2] = (7\,ms)$$

$$R_B^2 = 5\,ms + \left[\frac{7}{10} \times 4\right] \Rightarrow 5+3 = (8\,ms)$$

$$R_B^3 = 5\,ms + \left(\frac{8}{10} \times 4\,ms\right) \Rightarrow 5+4 = (9\,ms)$$

$R_B^4 = 5ms + \frac{7}{10} \times 4ms \Rightarrow \boxed{9ms}$ converges

$R_c \Rightarrow$ guess $R_c^0 = 0$

$$R_c^0 = C_c + \sum_{j \in (A,B)} \lceil \frac{0}{T_j} \rceil \Rightarrow C_c = 10ms$$

$$R_c^1 = 10ms + \left[\frac{10ms}{10} \times 4 + \frac{10ms}{20} \times 5\right] \Rightarrow 17ms$$

$$R_c^2 = 10ms + \left[\frac{17ms}{10} \times 4 + \frac{17ms}{20} \times 5\right] \Rightarrow 22ms$$

$$R_c^3 = 10ms + \left[\frac{22}{10} \times 4 + \frac{22}{20} \times 5\right] \Rightarrow 25ms$$

$$R_c^4 = 10ms + \left[\frac{25}{10} \times 4 + \frac{25}{20} \times 5\right] \Rightarrow 27ms$$

$$R_c^5 = 10ms + \left[\frac{27}{10} \times 4 + \frac{27}{20} \times 5\right] \Rightarrow 28ms$$

$$R_c^6 = 10ms + \left[\frac{28}{10} \times 4 + \frac{28}{20} \times 5\right] \Rightarrow 29ms$$

$$R_c^7 = 10 + \left[\frac{29}{10} \times 4 + \frac{29}{20} \times 5\right] \Rightarrow \boxed{29ms}$$

converges

$R_A \Rightarrow 4ms \Rightarrow$
$R_B \Rightarrow 9ms \Rightarrow$
$R_C \Rightarrow 29ms \Rightarrow$

task	Response(ms)	deadline	Result
A	4 ms	10ms	Beat by 6 m
B	9 ms	20ms	Beat by 11ms
C	29 ms	40ms	Beat by 11m