

ENSE 452 Assignment 3

1.	Tasks	Period	WCET
1		10ms	4ms
2		39ms	12ms
3		1000ms	98ms

$$U_1 = 4\text{ms}/10\text{ms} = 0.4$$

$$U_2 = 12\text{ms}/39\text{ms} = 0.3077$$

$$U_3 = 98\text{ms}/1000\text{ms} = 0.098$$

$$U = 0.4 + 0.3077 + 0.098 = 0.8057$$

$$U = 80.57\%$$

For a feasible schedule:

$$U \leq n(2^{\frac{1}{n}} - 1)$$

$$U \leq 3(2^{\frac{1}{3}} - 1)$$

$$U \leq 0.7798$$

$$U \leq 77.98\%$$

Therefore this tasks set is not guaranteed to have a feasible schedule, since $80.57\% > 77.98\%$.

The easiest rewrite would be to change the period of task to from 39ms to 40ms. This would make the task set harmonic, since with periods 10ms, 40ms, and 1000ms (1s), each task is a multiple of every shorter period. Now the RMS guarantees a feasible schedule for $U \leq 100\%$, which is true for our system.

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

i) $U_A = 4\text{ms}/10\text{ms} = 0.4$

$U_B = 5\text{ms}/20\text{ms} = 0.25$

$U_C = 10\text{ms}/40\text{ms} = 0.25$

$U = 0.4 + 0.25 + 0.25 = 0.9 = 90\%$.

ii) This task set is not RMS scheduled since Task B with a period of 20ms, has a lower priority than Task C which has a period of 40ms.
For RMS scheduled tasks, shorter periods MUST have higher priorities, it is fundamental to RMS.

iii) Task A

Highest priority, so $R_A = 4\text{ms}$

Task C

$$R_{C_1} = 10\text{ms} + \left\lceil \frac{10\text{ms}}{10\text{ms}} \right\rceil \cdot 4\text{ms} = 14\text{ms}$$

$$R_{C_2} = 10\text{ms} + \left\lceil \frac{14\text{ms}}{10\text{ms}} \right\rceil \cdot 4\text{ms} = 18\text{ms}$$

$$R_{C_3} = 10\text{ms} + \left\lceil \frac{18\text{ms}}{10\text{ms}} \right\rceil \cdot 4\text{ms} = 18\text{ms}$$

$$R_C = 18\text{ms}$$

Task B

$$R_{B_1} = 5\text{ms} + \left[\frac{5\text{ms}}{10\text{ms}} \right] \cdot 4\text{ms} + \left[\frac{5\text{ms}}{40\text{ms}} \right] \cdot 10\text{ms} = 19\text{ms}$$

$$R_{B_2} = 5\text{ms} + \left[\frac{19\text{ms}}{10\text{ms}} \right] \cdot 4\text{ms} + \left[\frac{19\text{ms}}{40\text{ms}} \right] \cdot 10\text{ms} = 23\text{ms}$$

$$R_{B_3} = 5\text{ms} + \left[\frac{23\text{ms}}{10\text{ms}} \right] \cdot 4\text{ms} + \left[\frac{23\text{ms}}{40\text{ms}} \right] \cdot 10\text{ms} = 27\text{ms}$$

$$R_{B_4} = 5\text{ms} + \left[\frac{27\text{ms}}{10\text{ms}} \right] \cdot 4\text{ms} + \left[\frac{27\text{ms}}{40\text{ms}} \right] \cdot 10\text{ms} = 27\text{ms}$$

$$R_B = 27\text{ms}$$

iv) $C_A - R_A = 10\text{ms} - 4\text{ms} = 6\text{ms}$

Task A beats its deadline by 6ms

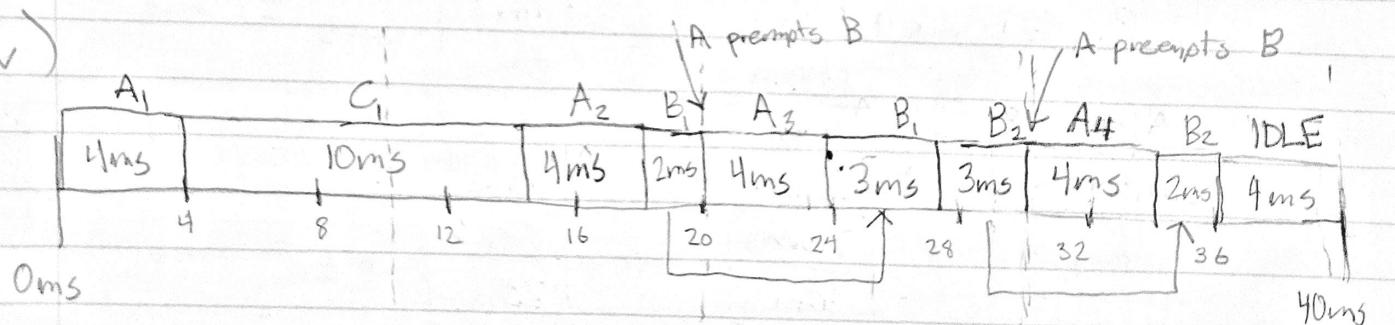
$$C_B - R_B = 20\text{ms} - 27\text{ms} = -7\text{ms}$$

Task B misses its deadline by 7ms

$$C_C - R_C = 40\text{ms} - 18\text{ms} = 22\text{ms}$$

Task C beats its deadline by 22ms

v)



1st A Cycle

10ms

2nd A Cycle

20ms

3rd A Cycle

30ms

4th A Cycle

40ms

1st B Cycle

20ms

2nd B Cycle

40ms

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b)

Task	Cycle	Execution Time	Priority
A	10	4	3 (highest)
B	20	5	2
C	40	10	1

i) System utilization is the same as before.
 $U = 90\%$.

ii) Task A

$$R_A = 4 \text{ ms}, \text{ highest priority task}$$

Task B

$$R_{B_1} = 5 \text{ ms} + \left[\frac{5 \text{ ms}}{10 \text{ ms}} \right] \cdot 4 \text{ ms} = 9 \text{ ms}$$

$$R_{B_2} = 5 \text{ ms} + \left[\frac{9 \text{ ms}}{10 \text{ ms}} \right] \cdot 4 \text{ ms} = 9 \text{ ms}$$

$$R_B = 9 \text{ ms}$$

Task C

$$R_{C_1} = 10 \text{ ms} + \left[\frac{10 \text{ ms}}{10 \text{ ms}} \right] \cdot 4 \text{ ms} + \left[\frac{10 \text{ ms}}{20 \text{ ms}} \right] \cdot 5 \text{ ms} = 19 \text{ ms}$$

$$R_{C_2} = 10 \text{ ms} + \left[\frac{19 \text{ ms}}{10 \text{ ms}} \right] \cdot 4 \text{ ms} + \left[\frac{19 \text{ ms}}{20 \text{ ms}} \right] \cdot 5 \text{ ms} = 23 \text{ ms}$$

$$R_{C_3} = 10 \text{ ms} + \left[\frac{23 \text{ ms}}{10 \text{ ms}} \right] \cdot 4 \text{ ms} + \left[\frac{23 \text{ ms}}{20 \text{ ms}} \right] \cdot 5 \text{ ms} = 32 \text{ ms}$$

$$R_{C_4} = 10 \text{ ms} + \left[\frac{32 \text{ ms}}{10 \text{ ms}} \right] \cdot 4 \text{ ms} + \left[\frac{32 \text{ ms}}{20 \text{ ms}} \right] \cdot 5 \text{ ms} = 36 \text{ ms}$$

$$R_{C_5} = 10 \text{ ms} + \left[\frac{36 \text{ ms}}{10 \text{ ms}} \right] \cdot 4 \text{ ms} + \left[\frac{36 \text{ ms}}{20 \text{ ms}} \right] \cdot 5 \text{ ms} = 36 \text{ ms}$$

$$R_C = 36 \text{ ms}$$

$$C_A - R_A = 10\text{ms} - 4\text{ms} = 6\text{ms}$$

Task A beats its deadline by 6ms

$$C_B - R_B = 20\text{ms} - 9\text{ms} = 11\text{ms}$$

Task B beats its deadline by 11ms

$$C_C - R_C = 40\text{ms} - 36\text{ms} = 4\text{ms}$$

Task C beats its deadline by 4ms

