1.

	period	WCET
T_1	10 ms	4 ms
T_2	39 ms	12 ms
T_3	1000 ms	98 ms

not harmonic

$$U = \sum_{i=0}^{n-1} \frac{c_i}{P_i}$$

$$U \le n(2^{1/n} - 1) \qquad = \frac{4}{10} + \frac{12}{39} + \frac{98}{1000}$$

$$\le 3(2^{1/3} - 1) \qquad = 80.57\%$$

$$\le 77.98\%$$

Task set does not have a feasible schedule according to RMS criteria.

Easiest way to change it would be to increase period of Task 2 to 40 ms, making the set harmonic allowing the RMS criterion to be maximum of 100th rather than 77.98%.

U if T_2 period is 40 ms would be:

$$\frac{4}{10} + \frac{12}{40} + \frac{98}{1000} = 0.798 = 79.8\%$$

which is less than 100%

2.

task	cycle	execution time	priority
Task A	10ms	4ms	3 (highest)
Task B	20ms	5ms	1
Task C	40ms	10ms	2
Idle	continuous	5ms	—

$U_{max} = 100\%$ b/c harmonic set

a) 1) $U = \sum_{i=0}^{n-1} \frac{C_i}{P_i} = \frac{4}{10} + \frac{5}{20} + \frac{10}{40} + \frac{5}{\infty}$

$= 90\%$

ii) Yes b/c the set is harmonic ∴ utilization has to be less than 100% and it is.

iii) $R_i^{k+1} = C_i + \sum_{\forall j \in h_p(i)} \left\lceil \frac{R_i^k}{P_j} \right\rceil C_j$

$C_0 = 4 \quad C_1 = 5 \quad C_2 = 10$

$P_0 = 10 \quad P_2 = 20 \quad P_3 = 40$

$h_p(0) = \{\} \quad h_p(1) = \{0,2\} \quad h_p(2) = \{0\}$

$R_0^0 = 0$

$R_0^1 = C_0 + \sum_{j \in \{\}} \left\lceil \frac{R_0^0}{P_j} \right\rceil C_j = C_0 \le 4ms$

$R_0^2 = C_0 + \frac{R_0^0}{P_j} C_j = 4ms$

converges ∴ $R_0 = 4ms$

$R_2^4 = 10 + \left\lceil \frac{18}{10} \right\rceil \cdot 4$

$= 18$

converges

$R_2^0 = 0$

$R_2^1 = C_2 + \left\lceil \frac{0 R_2^0}{P_i} \right\rceil C_j = 10 \, ms$

$R_2^2 = C_2 + \frac{R_2^1}{P_i} C_j = 10ms + \frac{10ms}{10ms} \cdot 4$

$j=0$

$= 14ms$

$R_2^3 = 10 + \left\lceil \frac{14}{10} \right\rceil \cdot 4$

$= 10 + 2 \cdot 4$

$= 18$

$R_1^0 \leq 0$

$R_1^1 = C_1 + \sum_{j \in \{0,1\}} \lceil \frac{R_1^0}{r_j} \rceil C_j$

$= 5 + \frac{0}{10} \cdot 4 + \frac{0}{40} \cdot 10$

$= 5ms$

$R_1^2 = 5 + \lceil \frac{5}{10} \rceil \cdot 4 + \lceil \frac{5}{40} \rceil \cdot 10$

$= 5 + 1 \cdot 4 + 1 \cdot 10$

$= 19$

$R_1^3 = 5 + \lceil \frac{19}{10} \rceil \cdot 4 + \lceil \frac{19}{40} \rceil \cdot 10$

$= 5 + 2 \cdot 4 + 1 \cdot 10$

$= 23$

$R_1^4 = 5 + \lceil \frac{23}{10} \rceil \cdot 4 + \lceil \frac{23}{40} \rceil \cdot 10$

$= 5 + 3 \cdot 4 + 1 \cdot 10$

$= 27$

$R_1^5 = 5 + \lceil \frac{27}{10} \rceil \cdot 4 + \lceil \frac{27}{40} \rceil \cdot 10$

$= 5 + 3 \cdot 4 + 1 \cdot 10$

$= 27 ms$

converge

idle

$R_3^0 = 0$

$R_3^1 = C_3 + \frac{0}{10} \cdot 4 + \frac{0}{40} \cdot 10 + \frac{0}{20} \cdot 5$

$= 5$

$R_3^2 = 5 + \frac{5}{10} \cdot 4 + \frac{5}{40} \cdot 10 + \frac{5}{20} \cdot 5$

$= 5 + 4 + 10 + 5$

$= 24$

$R_3^3 = 5 + 3 \cdot 4 + 1 \cdot 10 + 2 \cdot 5$

$= 37$

$R_3^4 = 5 + 4 \cdot 4 + 1 \cdot 10 + 2 \cdot 5$

$= 41$

$R_3^5 = 5 + 5 \cdot 4 + 2 \cdot 10 + 3 \cdot 5$

$= 60$

$R_3^6 = 5 + 6 \cdot 4 + 2 \cdot 10 \cdot 3 \cdot 5$

$= 64$

$R_3^7 = 5 + 7 \cdot 4 + 2 \cdot 10 + 4 \cdot 5$

$= 73$

$R_3^8 = 5 + 8 \cdot 4 + 2 \cdot 10 + 4 \cdot 5$

$= 78$

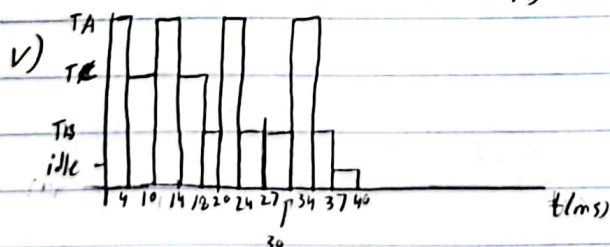$R_3^9 = 5 + 8 \cdot 4 + 2 \cdot 10 + 4 \cdot 5$

$= 78$

converge

iv) No, B doesn't meet its deadline.

A beats its deadline by 6ms
B exceeds its deadline by 7ms
C beats its deadline by 22 ms

v)

b) i) $U = \frac{4}{10} + \frac{5}{20} + \frac{10}{40}$

$= 90\%.$

ii)

$R_0^0 = 0$	$R_1^0 = 0$	$R_2^0 = 0$	$R_3^0 = 0$
$R_0^1 = C_0 + 0$	$R_1^1 = 5ms + \lceil\frac{0.7}{10}\rceil \cdot 4$	$R_2^1 = 10 + \frac{0}{10}\cdot 4 + \frac{0}{20}\cdot 5$	$R_3^1 = 5 + \frac{0}{10}\cdot 4 + \frac{2}{20}\cdot 5$
$= 4ms$	$= 5ms$	$= 10$	$+\frac{0}{40}\cdot 10$
$R_0^2 = C_0 + \frac{0}{4}$	$R_1^2 = 5 + \lceil\frac{5}{10}\rceil \cdot 4$	$R_2^2 = 10 + \lceil\frac{10}{10}\rceil\cdot 4 + \lceil\frac{10}{20}\rceil\cdot 5$	$= 5$
$= 4ms$	$= 9$	$= 19$	$R_3^2 = 24$
	$R_1^3 = 5 + \lceil\frac{9}{10}\rceil\cdot 4$	$R_2^3 = 10 + \lceil\frac{19}{10}\rceil + \lceil\frac{19}{20}\rceil\cdot 5$	$R_3^3 = 37$
	$= 9ms$	$= 23$	$R_3^4 = 41$
		$R_1^4 = 10 + \lceil\frac{23}{10}\rceil + \lceil\frac{23}{25}\rceil\cdot 5$	$R_3^5 = 60$
	$\ldots ms$	$= 32$	$R_3^6 = 64$
		$R_1^5 = 10 + \lceil\frac{32}{16}\rceil\cdot 4 + \lceil\frac{32}{20}\rceil\cdot 5$	$R_3^7 = 73$
		$= 36$	$R_3^8 = 78$

$R_1^6 = 10 + \lceil\frac{36}{10}\rceil + \lceil\frac{31}{20}\rceil\cdot 6$ $R_3^9 = 78 ms$

$= 36ms$

iii) A beats its deadline by 6ms
B beats its deadline by 11 ms
C beats its deadline by 4 ms

iv)

repeats after 40 ms