1. **(10 marks)** Consider a system that has three tasks with periods: 10 millisecond, 39 millisecond, and 1 second. If the WCETs have been estimated at 4 milliseconds, 12 milliseconds, and 98 milliseconds, respectively, what is the total time-loading of the system? (We are ignoring context switch time)

   Is the task set guaranteed to have a feasible schedule, by the RMS criterion? If not, what would be the *easiest* rewrite that would make the three tasks schedulable? Explain your answer

Sol: Task 1 Period: 10 ms
Task 2 Period: 39 ms
Task 3 Period: 1 second = 1000 ms

WCET's estimation for Task 1 = 4 ms
WCET's estimation for Task 2 = 12 ms
WCET's estimation for Task 3 = 98 ms
Total Loading of the system: $\frac{WCET's_{Task1}}{Period_{Task1}} + \frac{WCET's_{Task2}}{Period_{Task2}} + \frac{WCET's_{Task3}}{Period_{Task3}}$

$\Rightarrow \frac{4ms}{10ms} + \frac{12ms}{39ms} + \frac{98ms}{1000ms} \Rightarrow \underline{\underline{0.81}}$ → Rounded 2 digits

Lets look at feasibility of the schedule

$U \leq n(2^{1/n} - 1)$ where n are number of tasks and this equation guarantees feasible schedule

$U ! \leq n(2^{1/n} - 1) \Rightarrow 0.81 ! \leq 3(2^{1/3} - 1) \Rightarrow 0.81 ! \leq 0.78$

This means that it is not a guaranted feasible schedule.

Easier rewrite will be

$$\frac{4ms}{X} + \frac{12ms}{39ms} + \frac{98ms}{1000ms} = 0.78$$

$0.4057 + \frac{4ms}{x} = 0.75$

$x = 10.69$ so 11

Lets test it

$$\frac{4ms}{11\ ms} + \frac{12ms}{39ms} + \frac{98ms}{1000\ ms} = 0.769 \approx 0.77$$

11 ms, 39ms, 1000 ms gurantees feasible schedule

The reason why the period task 1 was chooren because it generates the higher ratio of $\frac{WCnet}{Period}$ which is 0.4. So, the increase will be by 1 second to meet feasible schedule.

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2. **(20 marks)** A preemptive system has three concurrent tasks, described by the table below (context switch time is ignored). The background, or idle task is assumed to be nonessential and is fully preemptable by all higher priority tasks.

Task	Cycle	Execution Time	Priority
TaskA	10ms	4ms	3 (highest)
TaskB	20ms	5ms	1
TaskC	40ms	10ms	2
Idle	(continuous)	5ms	—

(a) Answer the following:

i. What is the system utilization?

ii. Is this task set RMS scheduled?

iii. What is the response time for each task?

iv. Do all the tasks meet their deadlines? By how much does each task beat, or miss, its deadline.

v. Draw an execution time line for this system.

a i) System Utilization $= \frac{E.Time_{T1}}{Cycle_{T1}} + \frac{E.Time_{T2}}{Cycle_{T2}} + \frac{E.Time_{T3}}{Cycle_{T3}}$

$\Rightarrow \frac{4ms}{10ms} + \frac{5ms}{20ms} + \frac{10ms}{40ms} = 0.90$

ii) No, this task is not set RMS scheduled because TaskC's priority is higher than Task B's priority, whereas their cycles are 10ms and 5ms respectively.

iii) Since this task is not set RMS scheduled we can just simply say :- After each Task completes, Another one starts

TaskA :- 4ms

TaskC :- TaskA + 10ms = 14ms

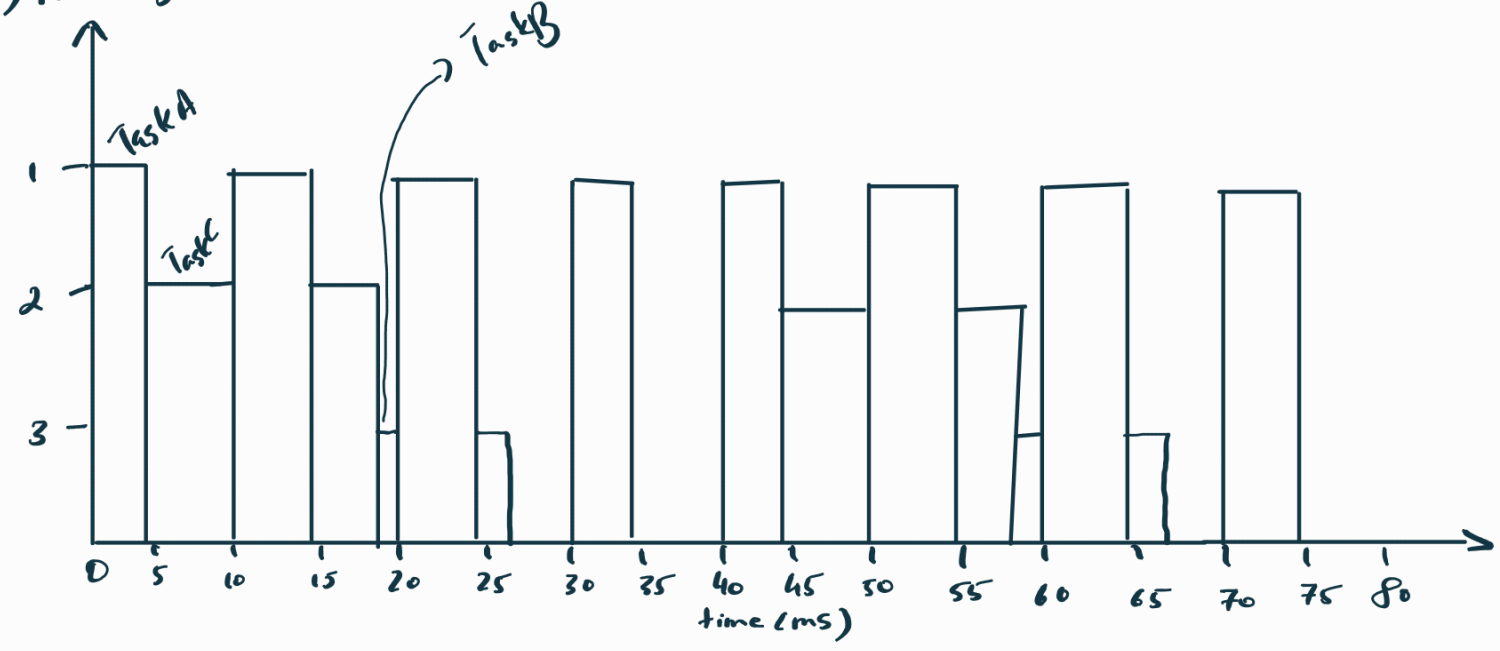
TaskB :- TaskA + TaskC + 5ms = 19 ms

iv) TaskA Deadline :- Cycle - Response Time = 10 - 4 = 6ms

TaskB Deadline :- Cycle - Response Time = 20 - 19 = 1ms

TaskC Deadline :- Cycle - Response Time = 40 - 14ms = 26ms

v) Priority



(b) Now suppose the priorities of Task B and C are interchanged, that is, TaskB has priority 2 and TaskC has priority 1. Answer the following:

i. What is the system utilization?

ii. What is the response time for each task?

iii. Do all the tasks meet their deadlines? By how much does each task beat, or miss, its deadline.

iv. Draw an execution time line for this system.

i) Same as before doesn't change

ii) Task A response time = 4ms

Task B response Time = 9ms

Task C response Time = 19ms

iii) Task A deadline = 10 - 4 = 6 ms

Task B deadline = 20 - 5 = 15ms

Task C deadline = 40 - 10 = 30ms

iv)