HW 4: Response Time and Real-Time Scheduling

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Question 1: Cyclic Executive

Part A

A system's total utilization is given by:

$$\sum_{i=1}^{n} \frac{C_i}{T_i}$$

Plugging in the values from the problem yields:

$$\frac{1}{3} + \frac{1}{4} + \frac{2}{6} + \frac{1}{12}$$

$$\frac{4+3+4+1}{12} = \frac{12}{12} = 100\%$$

Part B

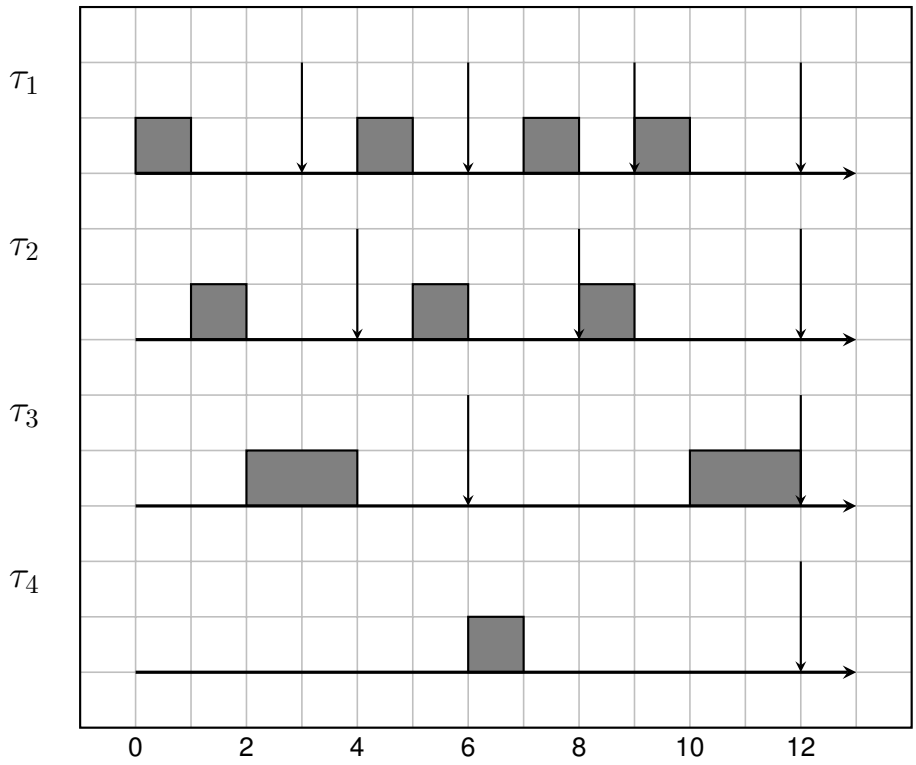

Figure 1: The downward arrow represents the deadline

Question 2: Interrupt Latency

Part A

$$ISRLatency_2^0 = 12$$

$$ISRLatency_2^1 = 12 + \left\lceil \frac{12}{30} \right\rceil 10 + \left\lceil \frac{12}{26} \right\rceil 4 = 12 + 10 + 4 = 26$$

$$ISRLatency_2^2 = 12 + \left\lceil \frac{26}{30} \right\rceil 10 + \left\lceil \frac{26}{26} \right\rceil 4 = 12 + 10 + 4 = 26$$

Max latency is 26 ms.

Part B

$$ISRLatency_2^0 = 24$$

$$ISRLatency_2^1 = 24 + \left\lceil \frac{24}{30} \right\rceil 10 + \left\lceil \frac{24}{26} \right\rceil 4 = 24 + 10 + 4 = 38$$

$$ISRLatency_2^2 = 24 + \left\lceil \frac{38}{30} \right\rceil 10 + \left\lceil \frac{38}{26} \right\rceil 4 = 24 + 20 + 8 = 52$$

Max latency is 52 ms.

Question 3: Preemptive Task Scheduling

Part A

In order to to determine schedulability we must see that $U \leq 1$.

$$U = \frac{13}{60} + \frac{8}{15} + \frac{5}{20}$$

$$U = \frac{13 + 32 + 15}{60}$$

$$U = \frac{60}{60} = 1$$

The system meets the EDF Schedulability Condition, therefore the system can be scheduled with EDF.

Part B

The system has a higher utilization then the bound ($U(3) = 0.780$). Need to apply RT test to determine schedulability.

$$R_3^0 = C_3 = 5$$

$$R_3^1 = 5 + \left\lceil \frac{5}{60} \right\rceil 13 + \left\lceil \frac{5}{15} \right\rceil 8 = 5 + 13 + 8 = 26$$

Not schedulable with Rate Monotonic because of violation of deadline of Task 3.

Part C

Task set is not harmonic because not schedulable with U = 1. Also 15 and 20 are not multiples of one another.

Part D

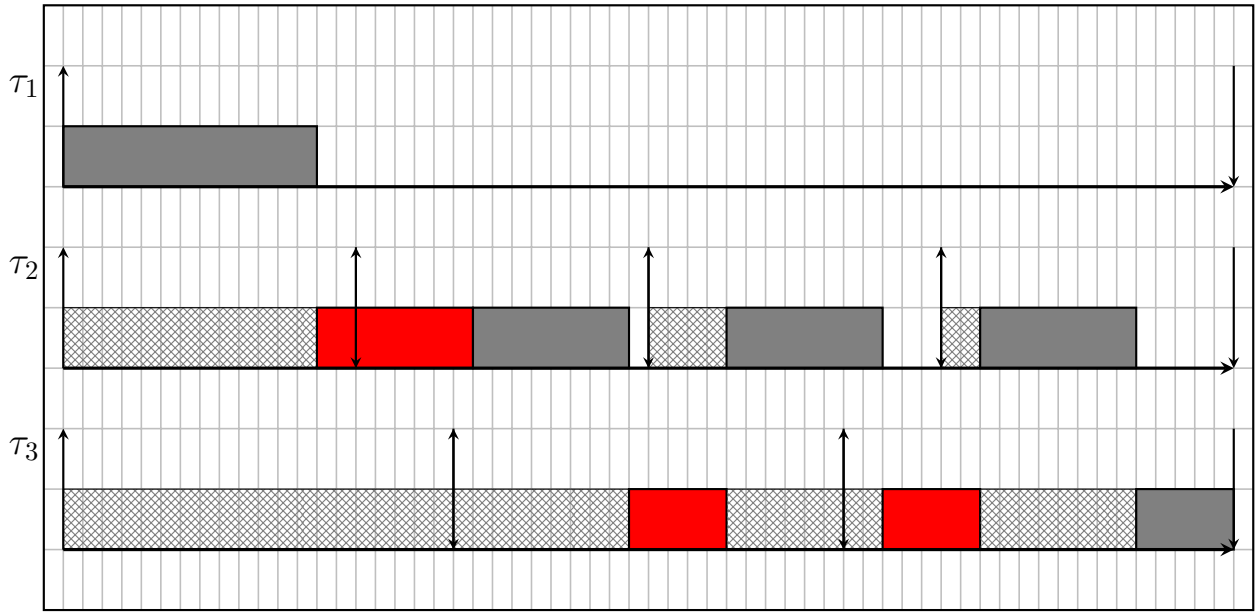

Figure 2: The downward arrow represents the deadline and the upward arrow represents the arrival of a task. If the box is red it means the task was not able to finish before it's deadline.