

# Homework assignment 2 - EL2450

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## 1

Rate Monotonic scheduling is a scheduling method that will predetermine the priority of each task proportional to the tasks activation frequency. The priority is determined at the task creation and will remain unchanged during the whole application.

## 2

A set of tasks  $J = \{J_1, J_2, \dots, J_n\}$  is schedulable with RM if

$$U = \sum_{i=1}^n \frac{C_i}{T_i} \leq n(2^{1/n} - 1) \quad (1)$$

where  $C_i$  is the computation time,  $T_i$  is the period,  $U$  is the utilization factor and  $n$  is the number of computations. When we have a sampling time of  $T = \{20, 29, 30\}ms$  and a computation time of 6 ms each we can see that,

$$\frac{6}{20} + \frac{6}{29} + \frac{6}{35} = 0.678 \quad (2)$$

and with a utilization factor of  $U = 0.780$  we can see that the set of tasks  $J$  should be schedulable with RM.

## 3

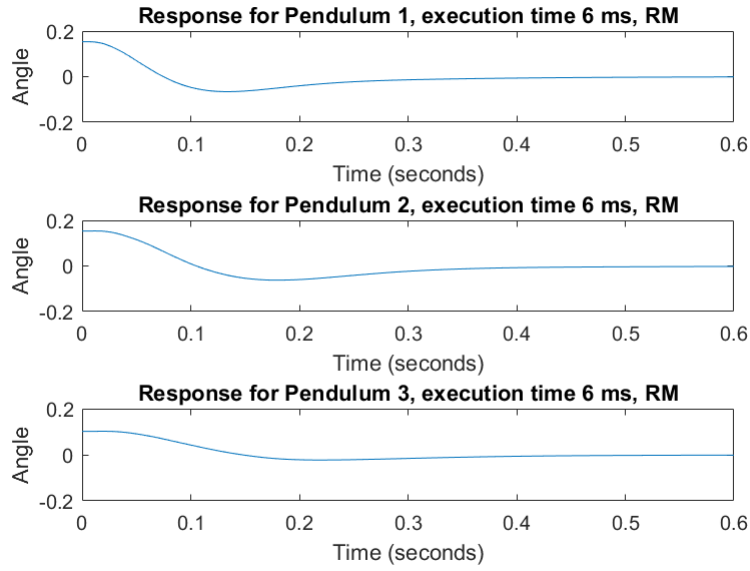


Figure 1: Pendulum angles for the three different pendulums

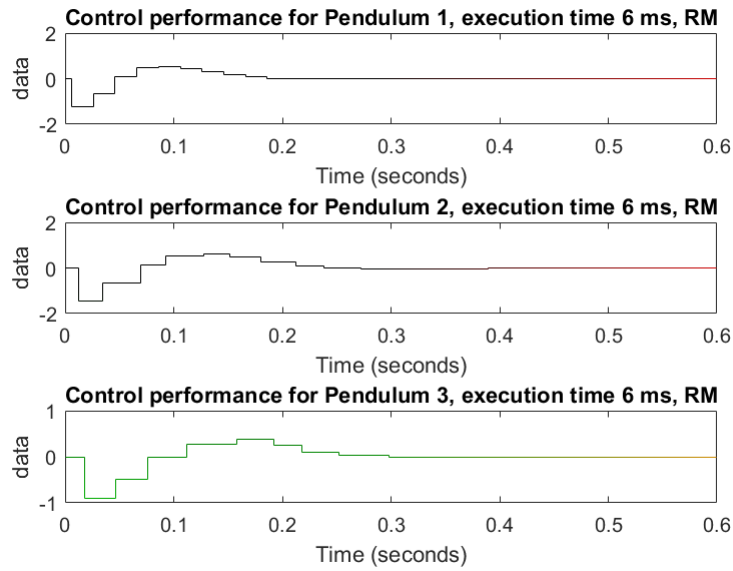


Figure 2: Control signal for pendulum

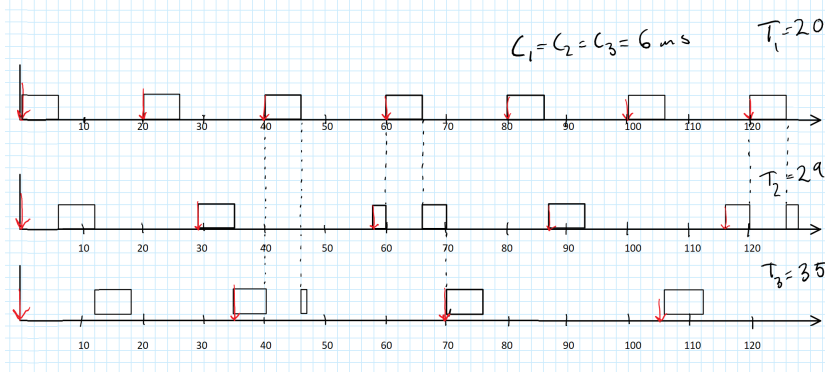


Figure 3: Our schedule for 6 ms computation time

The pendulums are indeed stabilized. There is however a slight difference in the control performance. From what we can see is the settling time longer the shorter the pendulum gets. Which is correct according to the lab introduction.

#### 4

The schedule plot from Simulink corresponds to our own schedule. This can be seen in figure 3 and 4. Be aware that our schedule is ordered from shortest-longest pendulum and the one from Simulink is longest-shortest pendulum.

#### 5

Our schedule for a computation time of 10 ms can be seen in figure 5. Deadlines are missed for the long pendulum which means that the tasks are not schedulable. This is verified by calculating the equation

$$U \leq n(2^{(1/n)} - 1) = 3 * (2^{(1/3)} - 1) = 0.779 \quad (3)$$

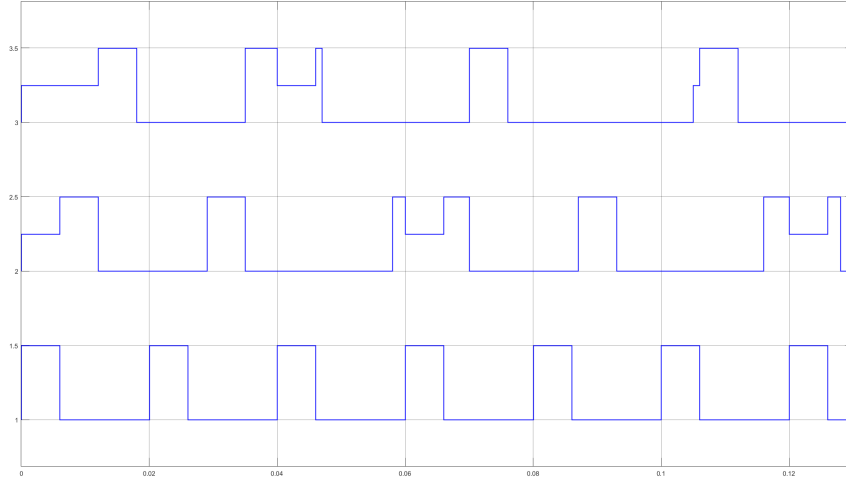


Figure 4: Schedule from Simulink for 6 ms

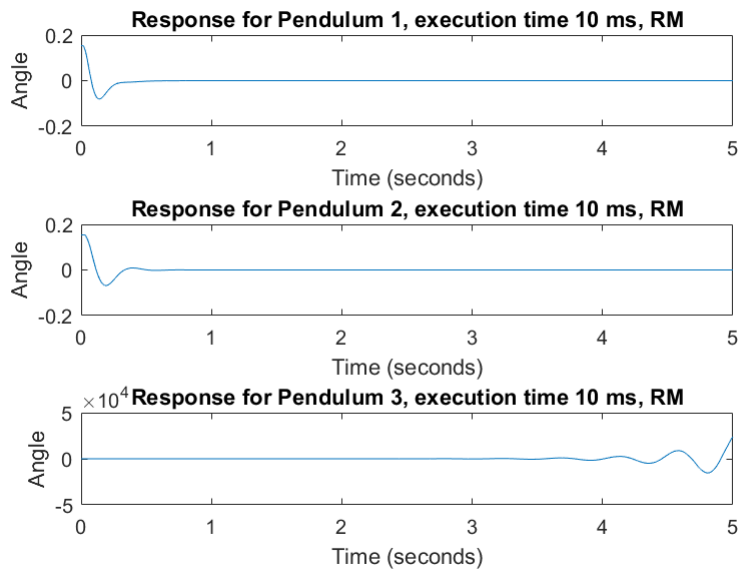


Figure 5: Pendulum angles for the three different pendulums

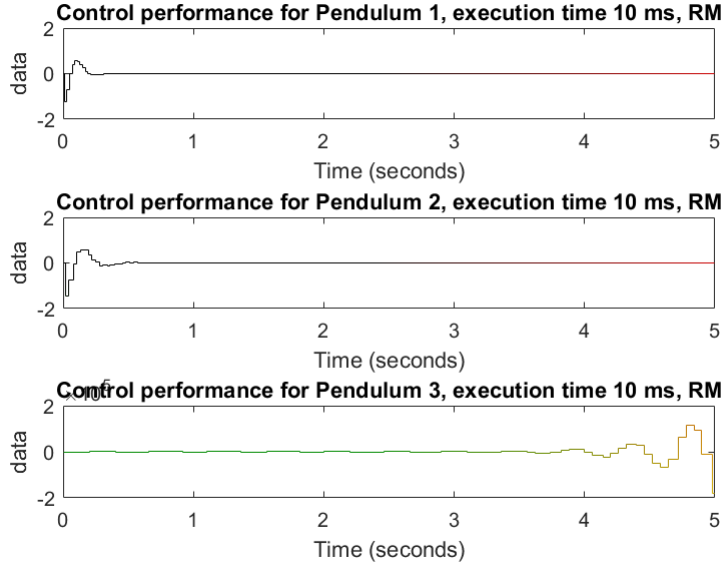


Figure 6: Control signal for pendulum

where

$$U = \sum_{i=1}^n \frac{C_i}{D_i} = \frac{10}{20} + \frac{10}{29} + \frac{10}{35} = 1.13 \quad (4)$$

This means that it is not schedulable due to

$$1.13 > 0.779 \quad (5)$$

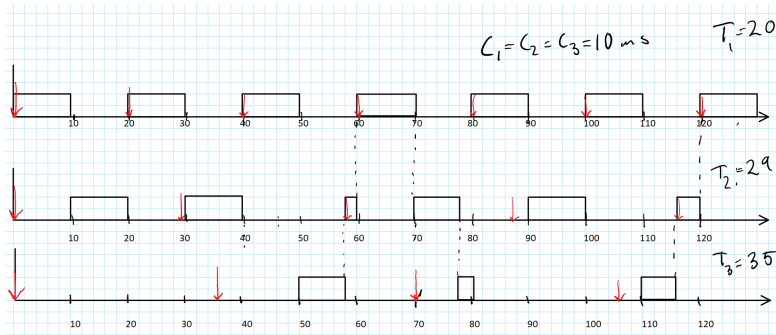


Figure 7: Our schedule for 10 ms computation time

## 6 Earliest Deadline First

### 6.1

Earliest deadline first scheduling executes the task with the shortest time left of its deadline  $d_k$ . This means that the schedule dynamically changes depending on the different task's deadlines. The advantages of EDF compared to RM is that EDF fully uses the processor computational power while RM is limited to  $U = n(2^{1/n} - 1)$ . Disadvantage is

### 6.2

The tasks are scheduable if

$$U \leq 1 \tag{6}$$

which in this case is

$$U = \frac{6}{20} + \frac{6}{29} + \frac{6}{35} = 0.678 \tag{7}$$

which is less than one.

### 6.3

### 6.4

Our schedule for EDF with 6 ms can be seen in figure NUMBER. The schedule from Simulink can be seen in figure NUMBER. The result from Simulink agrees with our schedule; all tasks are carried out before the next sampling time.

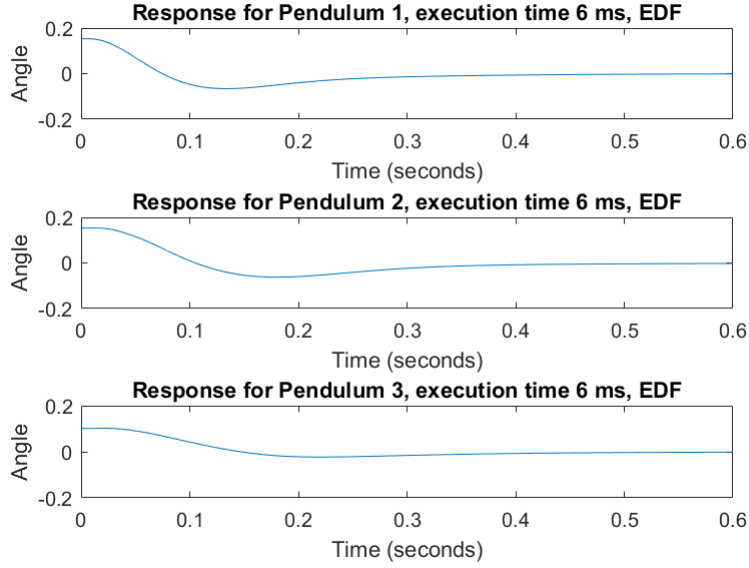


Figure 8: Pendulum angles for the three different pendulums

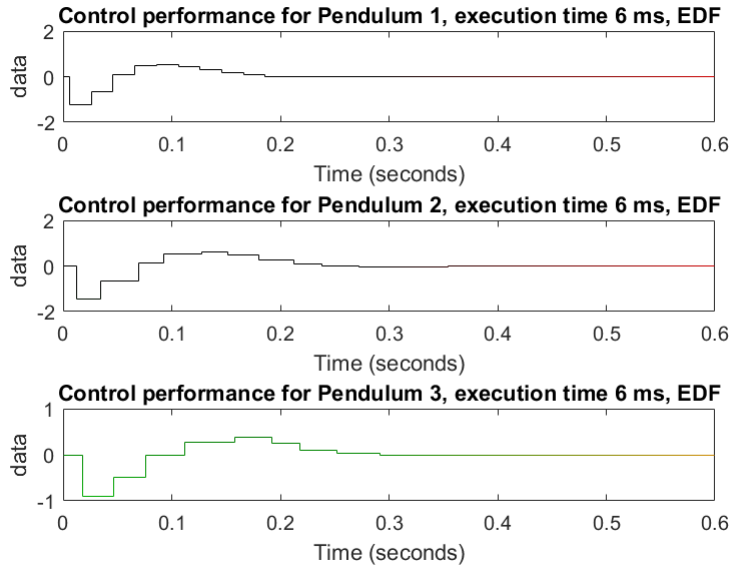


Figure 9: Control signal for the three different pendulums

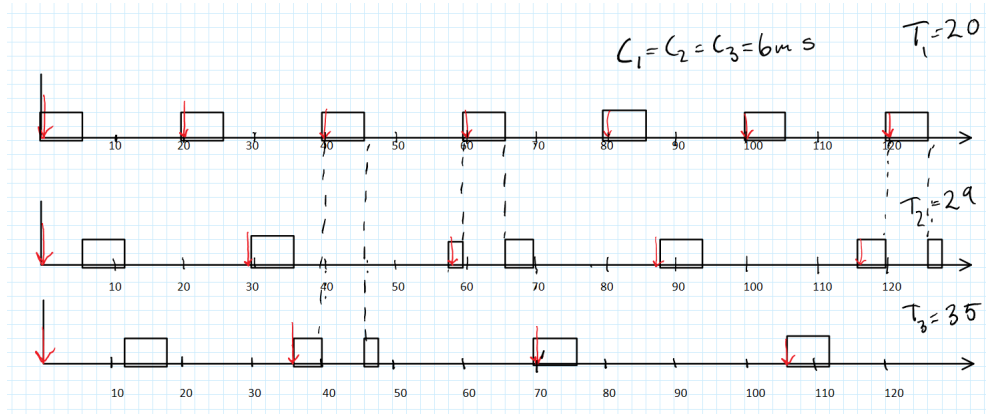


Figure 10: Our schedule for 6 ms computation time, EDF

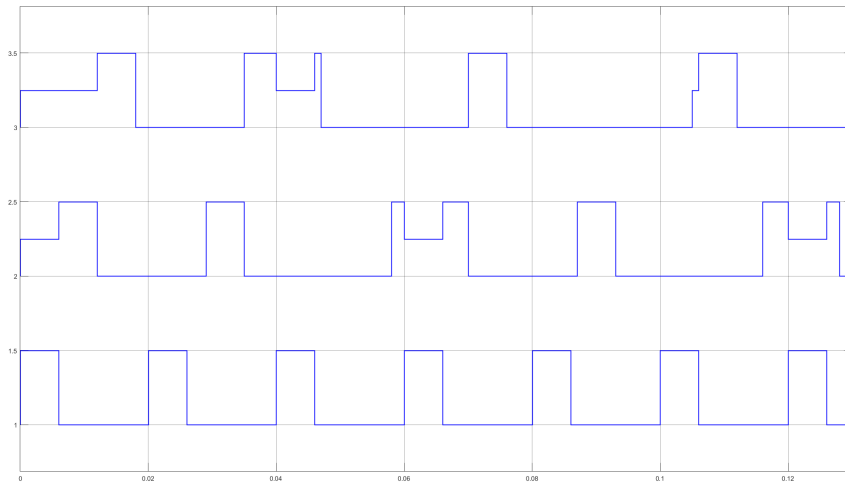


Figure 11: Simulink schedule for 6 ms computation time, EDF



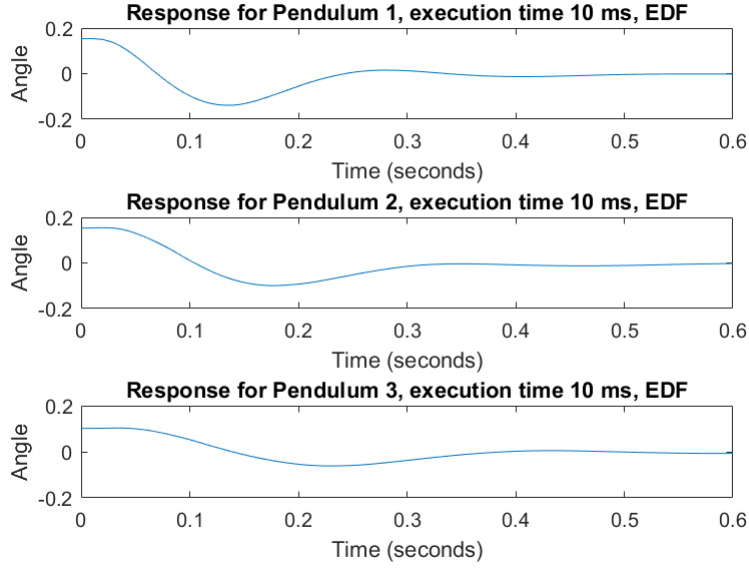


Figure 12: Pendulum angles for the three different pendulums, EDF

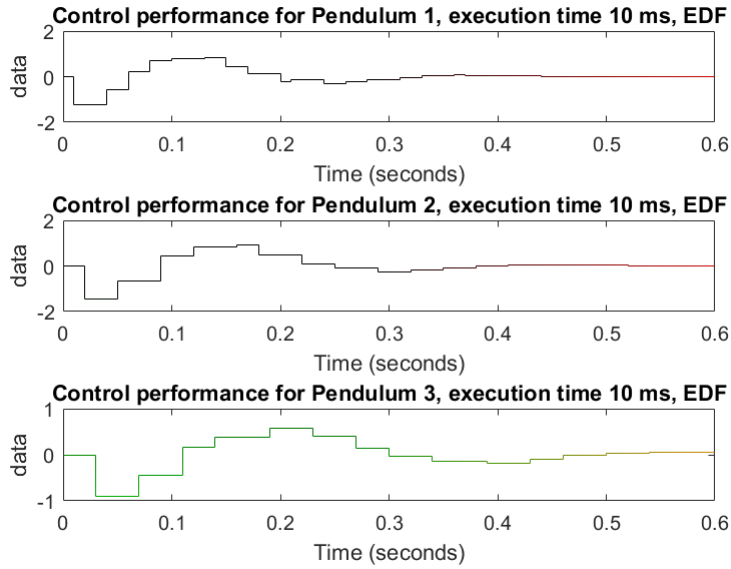


Figure 13: Control signal for the three different pendulums, EDF

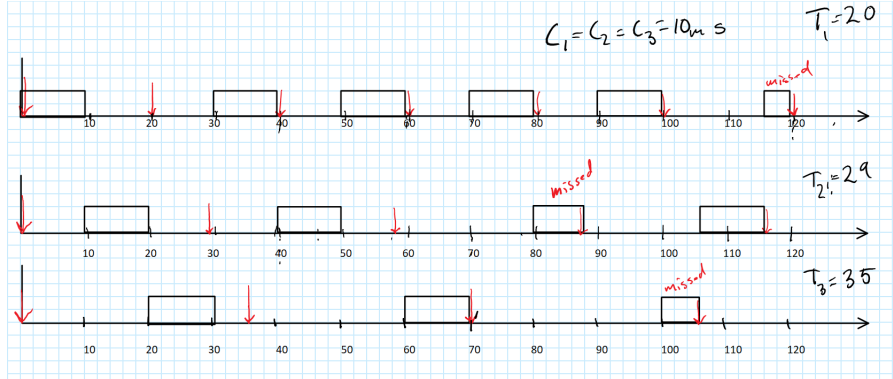


Figure 14: Our schedule for 10 ms computation time, EDF

## 6.5

The tasks are not scheduable with a computation time of 10 ms due to

$$U = \sum_{i=1}^n \frac{C_i}{D_i} = \frac{10}{20} + \frac{10}{29} + \frac{10}{35} = 1.13 > 1 \quad (8)$$

which we also verified when we created our schedule. Our schedule for a computation time of 10 ms with EDF is shown in figure NUMBER. Simulink schedule for a computation time of 10 ms is shown in figure NUMBER.

## 6.6

The controller is

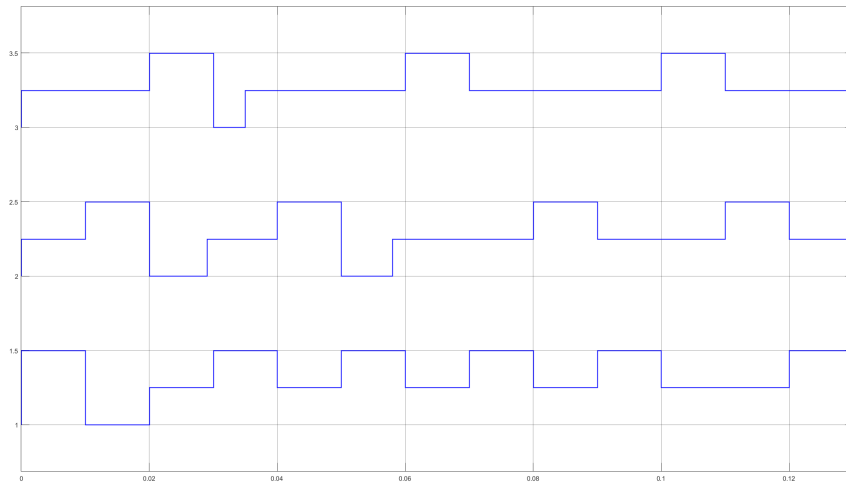


Figure 15: Simulink schedule for 10 ms computation time, EDF