

# *Bassant Ahmed Mohamed*

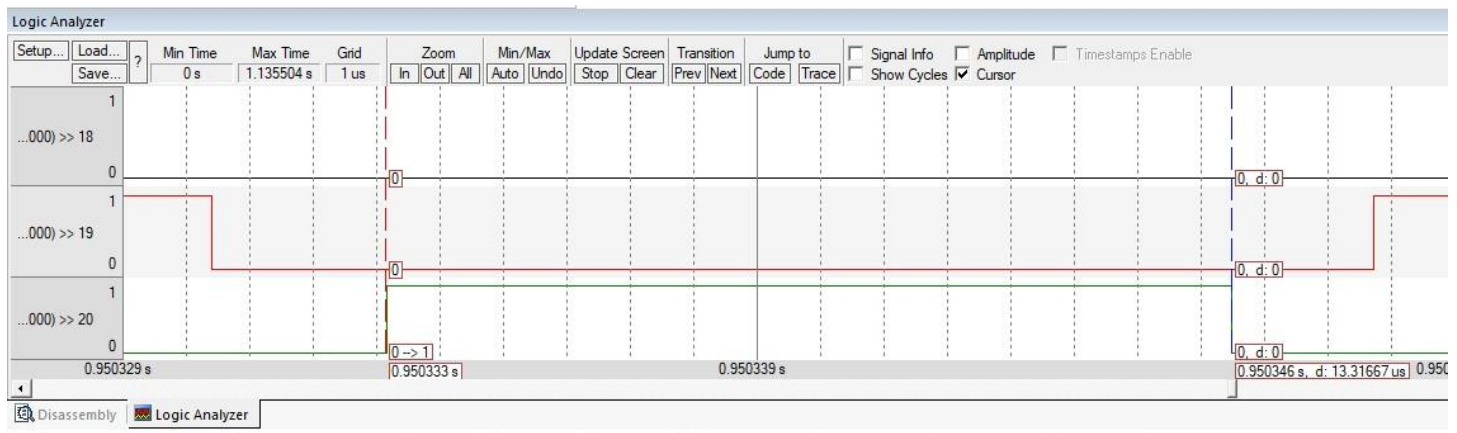
## *EDF Project Report*

Submitted to:

EgFwd Advanced Embedded System Track

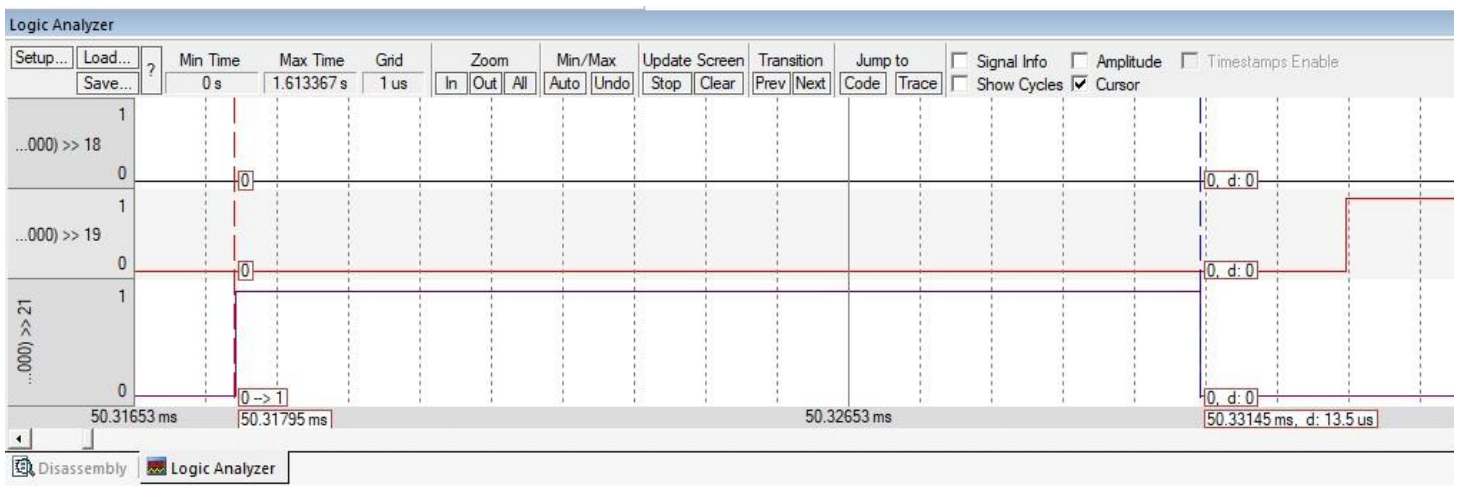
# 1.Tasks Periods

## 1.1 Button\_1\_Monitor Task



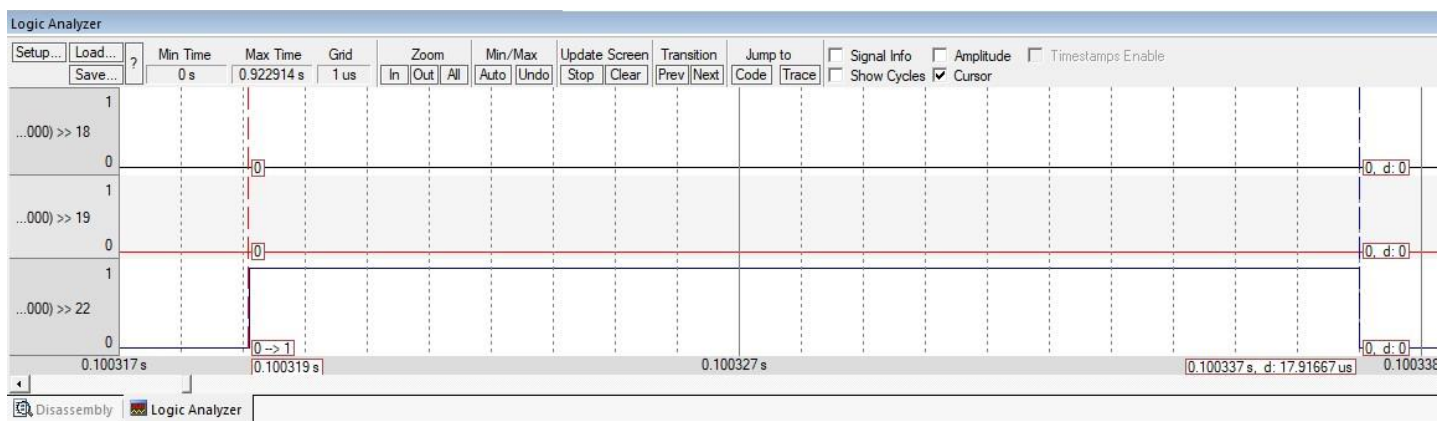
Period of Button\_1\_Monitor (Pin 20 in green) = 13.317 us

## 1.2 Button\_2\_Monitor Task



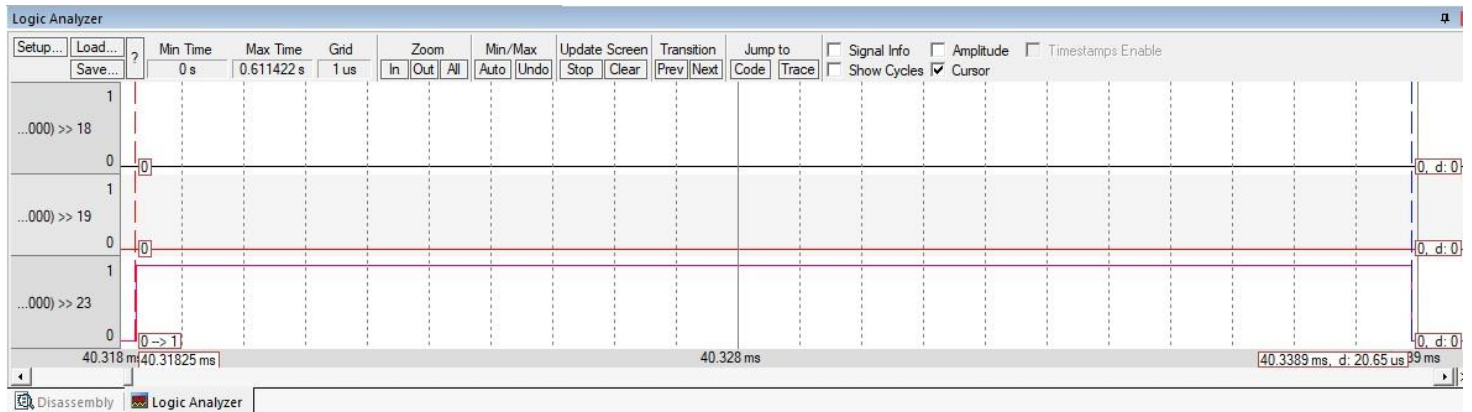
Period of Button\_2\_Monitor (Pin 21 in Purple ) = 13.5 us

## 1.3 Periodic\_Transmitter



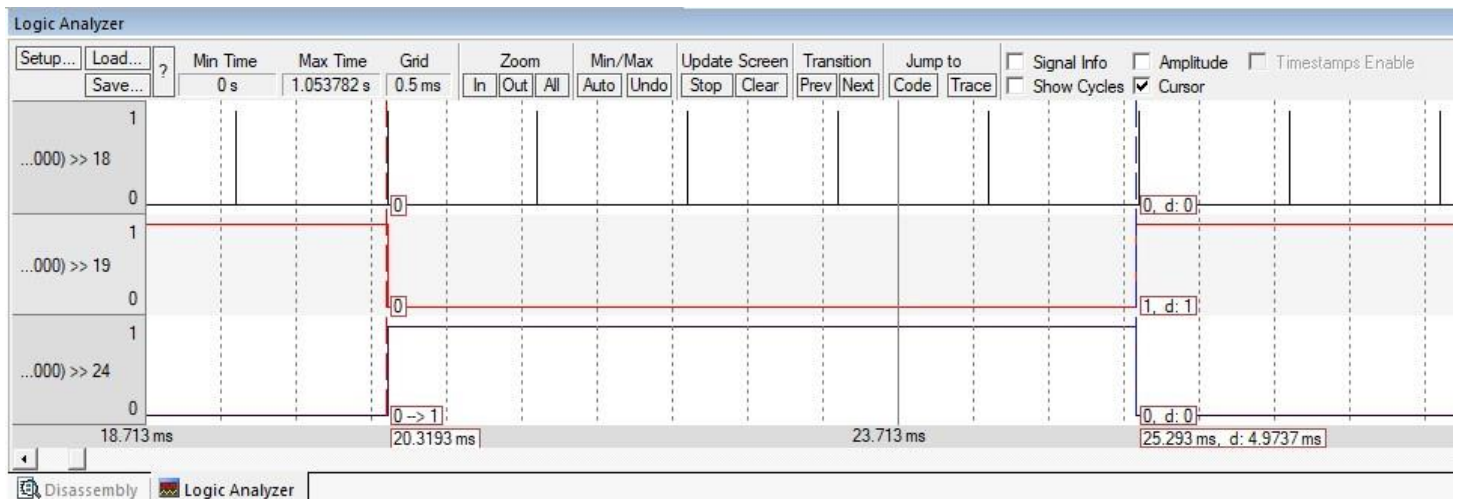
Period of Periodic\_Transmitter (Pin 22 in Blue ) = 17.92 us

## 1.4 UART\_Reciever



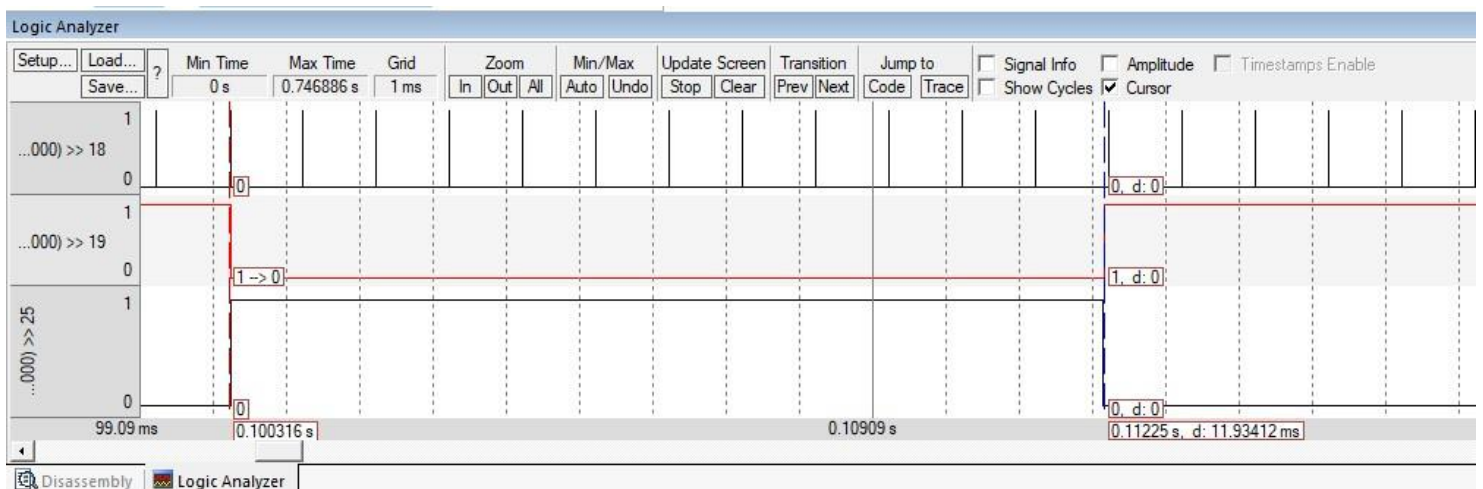
Period of UART\_Reciever (Pin 23 in Pink ) = 20.65 us

## 1.5 Load\_1\_Simulation



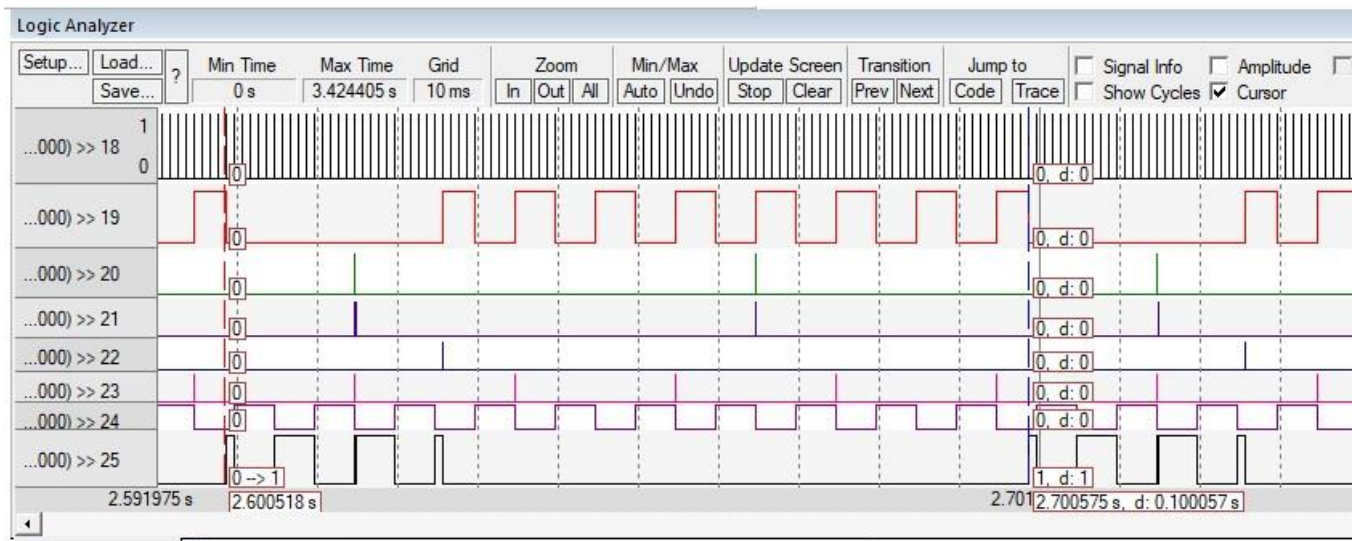
Period of Load\_1\_Simulation (Pin 24 in purple ) = 4.97 ms

## 1.6 Load\_2\_Simulation



Period of Load\_2\_Simulation (Pin 25 in Black ) = 11.93 ms

## 2. Calculating The System Hyperperiod



Hyperperiod = LCM (Pi) = 100 ms

Where Pi is all tasks periodicity.

## 3. Calculating The CPU Load (U)

$$U = \frac{R}{C} \text{ OR } \frac{\text{Total tasks' exequation time}}{\text{hyperperiod}}$$

Total tasks exequation time = (2 \* 13.317 us) + (2 \* 13.5us) + 17.92us + (5 \* 20.65us) + (10 \* 4.9ms) + 11.93ms = 61.1ms

$$U = \frac{61.1ms}{100ms} * 100 = 61.1\%$$

## 4. Checking System Shedulability

### 4.1 RM Utilization Bound

$$URM = n \left( 2^{\frac{1}{n}} - 1 \right)$$

Where n is the number of tasks.

$$URM = 6 \left( 2^{\frac{1}{6}} - 1 \right) = 0.735$$

$U < URM \rightarrow$  then system is schedulable .

### 4.2 Time Demand Analysis

Critical instant = hyperperiod = 100 ms

- Calculate time demand for Button\_1\_Monitor task (P:50 ms , E:13.317us , D:50ms)

$$W(1) = 13.317 \text{ us} + 0 = 13.317us$$

$$W(10) = 13.317 \text{ us} + \left(\frac{10}{10}\right) * 5 \text{ ms} = 5 \text{ ms}$$

$$W(20) = 13.317 \text{ us} + \left(\frac{20}{10}\right) * 5 \text{ ms} + \left(\frac{20}{20}\right) * 20.65 \text{ us} = 10 \text{ ms}$$

$$W(30) = 13.317 \text{ us} + \left(\frac{30}{10}\right) * 5 \text{ ms} + \left(\frac{30}{20}\right) * 20.65 \text{ us} = 15 \text{ ms}$$

$$W(40) = 13.317 \text{ us} + \left(\frac{40}{10}\right) * 5 \text{ ms} + \left(\frac{40}{20}\right) * 20.65 \text{ us} = 20 \text{ ms}$$

$$W(50) = 13.317 \text{ us} + \left(\frac{50}{10}\right) * 5 \text{ ms} + \left(\frac{50}{20}\right) * 20.65 \text{ us} = 25 \text{ ms}$$

$W(50) < 50 \text{ ms}$  ---> Button\_1\_Monitor is schedulable

- **Calculate time demand for Button\_2\_Monitor task (P:50 ms , E:13.5us , D:50ms)**

$$W(1) = 13.5 \text{ us} + 0 = 13.5 \text{ us}$$

$$W(10) = 13.5 \text{ us} + \left(\frac{10}{10}\right) * 5 \text{ ms} = 5 \text{ ms}$$

$$W(20) = 13.5 \text{ us} + \left(\frac{20}{10}\right) * 5 \text{ ms} + \left(\frac{20}{20}\right) * 20.65 \text{ us} = 10 \text{ ms}$$

$$W(30) = 13.5 \text{ us} + \left(\frac{30}{10}\right) * 5 \text{ ms} + \left(\frac{30}{20}\right) * 20.65 \text{ us} = 15 \text{ ms}$$

$$W(40) = 13.5 \text{ us} + \left(\frac{40}{10}\right) * 5 \text{ ms} + \left(\frac{40}{20}\right) * 20.65 \text{ us} = 20 \text{ ms}$$

$$W(50) = 13.5 \text{ us} + \left(\frac{50}{10}\right) * 5 \text{ ms} + \left(\frac{50}{20}\right) * 20.65 \text{ us} = 25 \text{ ms}$$

$W(50) < 50 \text{ ms}$  ---> Button\_2\_Monitor is schedulable

- **Calculate time demand for Periodic\_Transmitter task (P:100 ms , E:17.92us , D:100ms)**

$$W(1) = 17.92 \text{ us} + 0 = 17.92 \text{ us}$$

$$W(10) = 17.92 \text{ us} + \left(\frac{10}{10}\right) * 5 \text{ ms} = 5 \text{ ms}$$

$$W(20) = 17.92 \text{ us} + \left(\frac{20}{10}\right) * 5 \text{ ms} + \left(\frac{20}{20}\right) * 20.65 \text{ us} + \left(\frac{20}{50}\right) * 13.317 \text{ us} + \left(\frac{20}{50}\right) * 13.5 \text{ us} + \left(\frac{20}{100}\right) * 11.93 \text{ ms} = 12 \text{ ms}$$

$$W(30) = 17.92 \text{ us} + \left(\frac{30}{10}\right) * 5 \text{ ms} + \left(\frac{30}{20}\right) * 20.65 \text{ us} + \left(\frac{30}{50}\right) * 13.317 \text{ us} + \left(\frac{30}{50}\right) * 13.5 \text{ us} + \left(\frac{30}{100}\right) * 11.93 \text{ ms} = 18.6 \text{ ms}$$

$$W(40) = 17.92 \text{ us} + \left(\frac{40}{10}\right) * 5 \text{ ms} + \left(\frac{40}{20}\right) * 20.65 \text{ us} + \left(\frac{40}{50}\right) * 13.317 \text{ us} + \left(\frac{40}{50}\right) * 13.5 \text{ us} + \left(\frac{40}{100}\right) * 11.93 \text{ ms} = 24.8 \text{ ms}$$

$$W(50) = 17.92 \text{ us} + \left(\frac{50}{10}\right) * 5 \text{ ms} + \left(\frac{50}{20}\right) * 20.65 \text{ us} + \left(\frac{50}{50}\right) * 13.317 \text{ us} + \left(\frac{50}{50}\right) * 13.5 \text{ us} + \left(\frac{50}{100}\right) * 11.93 \text{ ms} = 31 \text{ ms}$$

$$W(60) = 17.92 \text{ us} + \left(\frac{60}{10}\right) * 5 \text{ ms} + \left(\frac{60}{20}\right) * 20.65 \text{ us} + \left(\frac{60}{50}\right) * 13.317 \text{ us} + \left(\frac{60}{50}\right) * 13.5 \text{ us} + \left(\frac{60}{100}\right) * 11.93 \text{ ms} = 37 \text{ ms}$$

$$W(70) = 17.92 \text{ us} + \left(\frac{70}{10}\right) * 5 \text{ ms} + \left(\frac{70}{20}\right) * 20.65 \text{ us} + \left(\frac{70}{50}\right) * 13.317 \text{ us} + \left(\frac{70}{50}\right) * 13.5 \text{ us} + \left(\frac{70}{100}\right) * 11.93 \text{ ms} = 43 \text{ ms}$$

$$W(80) = 17.92 \text{ us} + \left(\frac{80}{10}\right) * 5 \text{ ms} + \left(\frac{80}{20}\right) * 20.65 \text{ us} + \left(\frac{80}{50}\right) * 13.317 \text{ us} + \left(\frac{80}{50}\right) * 13.5 \text{ us} + \left(\frac{80}{100}\right) * 11.93 \text{ ms} = 49.5 \text{ ms}$$

$$W(90) = 17.92 \text{ us} + \left(\frac{90}{10}\right) * 5 \text{ ms} + \left(\frac{90}{20}\right) * 20.65 \text{ us} + \left(\frac{90}{50}\right) * 13.317 \text{ us} + \left(\frac{90}{50}\right) * 13.5 \text{ us} + \left(\frac{90}{100}\right) * 11.93 \text{ ms} = 55.8 \text{ ms}$$

$$W(100) = 17.92 \text{ us} + \left(\frac{100}{10}\right) * 5 \text{ ms} + \left(\frac{100}{20}\right) * 20.65 \text{ us} + \left(\frac{100}{50}\right) * 13.317 \text{ us} + \left(\frac{100}{50}\right) * 13.5 \text{ us} + \left(\frac{100}{100}\right) * 11.93 \text{ ms} = 62 \text{ ms}$$

$W(100) < 100 \text{ ms}$  ---> Periodic\_Transmitter is schedulable

- **Calculate time demand for UART\_Reciever task (P:20 ms , E:20.65us , D:20ms)**

$$W(1) = 20.65 \text{ us} + 0 = 20.65 \text{ us}$$

$$W(10) = 20.65 \text{ us} + \left(\frac{10}{10}\right) * 5 \text{ ms} = 5 \text{ ms}$$

$$W(20) = 20.65 \text{ us} + \left(\frac{20}{10}\right) * 5 \text{ ms} = 10 \text{ ms}$$

$W(20) < 20 \text{ ms}$  ---> UART\_Reciever is schedulable

- **Calculate time demand for Load\_1\_Simulation task (P:10 ms , E:5 ms , D:10ms)**

$$W(1) = 5 \text{ ms} + 0 = 5 \text{ ms}$$

$$W(10) = 5 \text{ ms} + 0 = 5 \text{ ms}$$

$W(20) < 10 \text{ ms}$  ---> Load\_1\_Simulation is schedulable

- **Calculate time demand for Load\_2\_Simulation task (P:100 ms , E:12 ms , D:100ms)**

$$W(1) = 12 \text{ ms} + 0 = 12 \text{ ms}$$

$$W(10) = 12 \text{ ms} + \left(\frac{10}{10}\right) * 5 \text{ ms} = 17 \text{ ms}$$

$$W(20) = 12 \text{ ms} + \left(\frac{20}{10}\right) * 5 \text{ ms} + \left(\frac{20}{20}\right) * 20.65 \text{ us} + \left(\frac{20}{50}\right) * 13.317 \text{ us} + \left(\frac{20}{50}\right) * 13.5 \text{ us} + \left(\frac{20}{100}\right) * 17.92 \text{ us} = 22 \text{ ms}$$

$$W(30) = 12 \text{ ms} + \left(\frac{30}{10}\right) * 5 \text{ ms} + \left(\frac{30}{20}\right) * 20.65 \text{ us} + \left(\frac{30}{50}\right) * 13.317 \text{ us} + \left(\frac{30}{50}\right) * 13.5 \text{ us} + \left(\frac{30}{100}\right) * 17.92 \text{ us} = 27 \text{ ms}$$

$$W(40) = 12 \text{ ms} + \left(\frac{40}{10}\right) * 5 \text{ ms} + \left(\frac{40}{20}\right) * 20.65 \text{ us} + \left(\frac{40}{50}\right) * 13.317 \text{ us} + \left(\frac{40}{50}\right) * 13.5 \text{ us} + \left(\frac{40}{100}\right) * 17.92 \text{ us} = 32 \text{ ms}$$

$$W(50) = 12 \text{ ms} + \left(\frac{50}{10}\right) * 5 \text{ ms} + \left(\frac{50}{20}\right) * 20.65 \text{ us} + \left(\frac{50}{50}\right) * 13.317 \text{ us} + \left(\frac{50}{50}\right) * 13.5 \text{ us} + \left(\frac{50}{100}\right) * 17.92 \text{ us} = 37 \text{ ms}$$

$$W(60) = 12 \text{ ms} + \left(\frac{60}{10}\right) * 5 \text{ ms} + \left(\frac{60}{20}\right) * 20.65 \text{ us} + \left(\frac{60}{50}\right) * 13.317 \text{ us} + \left(\frac{60}{50}\right) * 13.5 \text{ us} + \left(\frac{60}{100}\right) * 17.92 \text{ us} = 42 \text{ ms}$$

$$W(70) = 12 \text{ ms} + \left(\frac{70}{10}\right) * 5 \text{ ms} + \left(\frac{70}{20}\right) * 20.65 \text{ us} + \left(\frac{70}{50}\right) * 13.317 \text{ us} + \left(\frac{70}{50}\right) * 13.5 \text{ us} + \left(\frac{70}{100}\right) * 17.92 \text{ us} = 47 \text{ ms}$$

$$W(80) = 12 \text{ ms} + \left(\frac{80}{10}\right) * 5 \text{ ms} + \left(\frac{80}{20}\right) * 20.65 \text{ us} + \left(\frac{80}{50}\right) * 13.317 \text{ us} + \left(\frac{80}{50}\right) * 13.5 \text{ us} + \left(\frac{80}{100}\right) * 17.92 \text{ us} = 52 \text{ ms}$$

$$W(90) = 12 \text{ ms} + \left(\frac{90}{10}\right) * 5 \text{ ms} + \left(\frac{90}{20}\right) * 20.65 \text{ us} + \left(\frac{90}{50}\right) * 13.317 \text{ us} + \left(\frac{90}{50}\right) * 13.5 \text{ us} + \left(\frac{90}{100}\right) * 17.92 \text{ us} = 57 \text{ ms}$$

$$W(100) = 12 \text{ ms} + \left(\frac{100}{10}\right) * 5 \text{ ms} + \left(\frac{100}{20}\right) * 20.65 \text{ us} + \left(\frac{100}{50}\right) * 13.317 \text{ us} + \left(\frac{100}{50}\right) * 13.5 \text{ us} + \left(\frac{100}{100}\right) * 17.92 \text{ us} = 62 \text{ ms}$$

$W(100) < 100 \text{ ms}$  ---> Load\_2\_Simulation is schedulable

## 5. Using Offline Simulator (SimSo)

The screenshot shows the Qt Model data window on the left and the Qt Results window on the right.

**Qt Model data window:**

ms	List of Act. dates (ms)	Deadline (ms)	WCET (ms)	Followed by
50	-	50	0.013317	
100	-	100	0.0135	
20.0	-	20.0	0.1792	
10	-	10	4.97	
100	-	100	11.93	

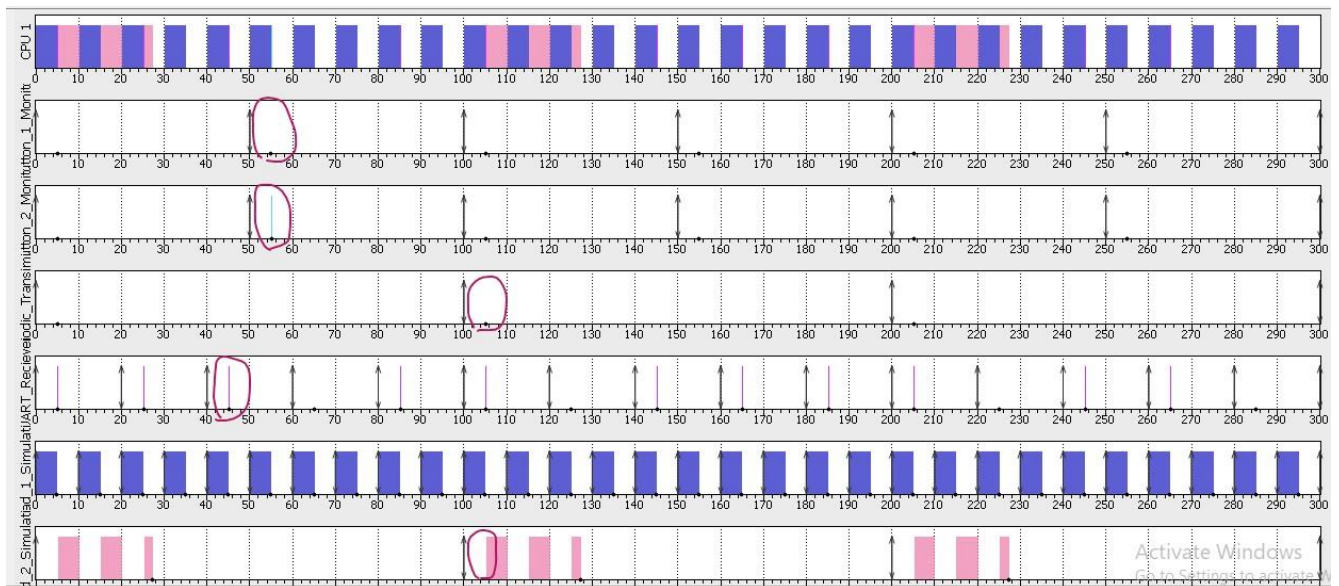
Buttons: Edit data fields..., Remove selected task(s), Add task, Generate Task Set

**Qt Results window:**

General | Logs | Tasks | Scheduler | Processors

Observation Window: from 0.00 to 300.00 ms [Configure...]

	Total load	Payload	System load
CPU 1	0.6259	0.6259	0.0000
Average	0.6259	0.6259	0.0000



## 6. Notes

- Simulating on SimSo didn't run as expected in Periodic\_Transmitter task, as in Keil the task start execution at the end of the other 5 tasks execution and before going again to the idle task.
- The system successfully ran as the implementation of the EDF scheduler.