



MIDDLE EAST TECHNICAL UNIVERSITY

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS
ENGINEERING**

**EE407
PROCESS CONTROL
LABORATORY**

**EXPERIMENT 4
LUMPED APPROXIMATIONS**

Date of the Experiment:

03/12/2018

Lab Group:

Monday Afternoon 1

Group Members:

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I. Results and Discussion

1.

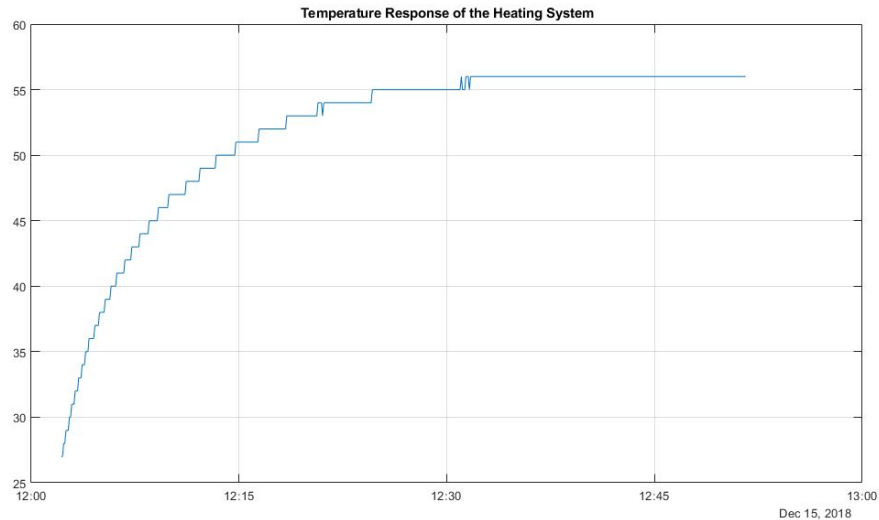


Figure 1: The Experimental Response of the heating system

The curve in general fits the one found in the preliminary work expect the time constant. Since, in the preliminary work, in order to speed up the simulation we have used a time constant that is 10^{-5} times of what the real one was. Thus, this is also expectable.

2. In non-interacting systems, each input affects more than one of outputs, in other words, a change in one of the outputs affects the other outputs. Because there are many feedback loop in the block diagram of the system of non-interacting RC stages, non-interacting RC stages are not proper for this system. The analogy between electrical circuits and heat conduction is expressed as:

$$R = \frac{1}{\text{Thermal Conductivity}} \quad C = \text{Heat Capacity}$$

3.

The increase of the order of the lumped model increases the degree of accuracy of approximation. When the order increases, the system response gets closer the ideal system response. This is also observed in preliminary work's third question.

4. taking measurements far away from $x=0$ or close to L makes the system response slower in reaching to the steady state. In other words the time constant increases as the measurement point is selected farther from origin. The reason is that the time constant of the solution of the differential equation is dependent on x value as shown in the appendix part of the experiment manual.

II. Conclusions

In this experiment, the thermal diffusion process which is a distributed system is observed. The derivation of the distributed system is understood well together with Process Control lessons and experiment. To observe distributed system, the temperature variations experiment is done. Lumped parameter approximation is discretize the space variable at the beginning and obtain a higher order ordinary differential equation. The electrical lumped parameter approximation with different orders is observed.