MISR UNIVERSITY FOR SCIENCE AND TECHNOLOGY
COLLEGE OF ENGINEERING
MECHATRONICS DEPARTMENT

MTE 506 DIGITAL CONTROL

LAB 1 – SPRING 2020

Lab 1

Goals of The Lab

Discretization of Analog Control Systems

- Assertion on the notion of modeling and simulation
- Converting a dynamic system to mathematical model

Lab 1

Software For Simulation

Needed for all labs

MATLAB

R2017b or above

Student must install software in advance before attending any lab

Lab 1

Simulating Water Tank

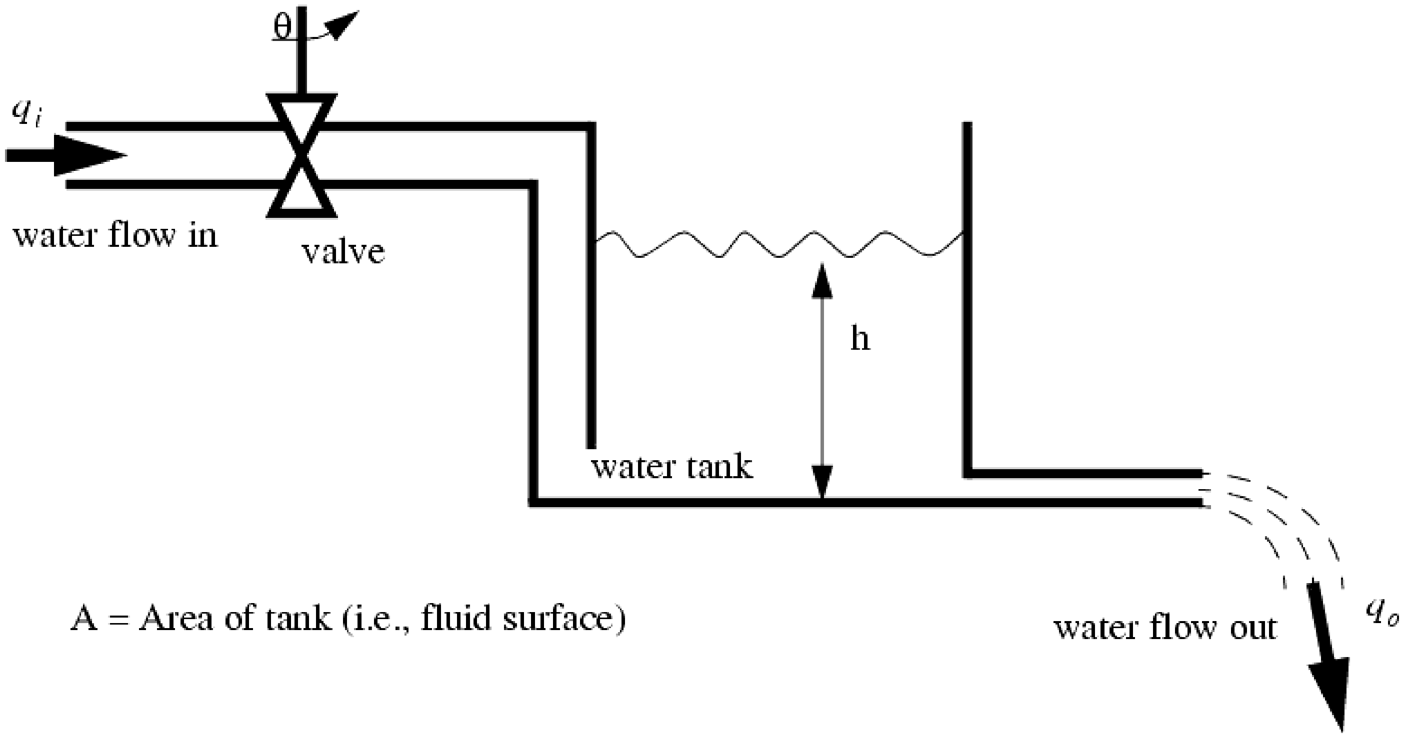
From physical simulation to modeling

Simulating behavior

Using MATLAB script for simulation

Mathematical Modeling

Using Simulink for implementing tank response



Lab 1

Quick review on concepts

Mechatronics notation

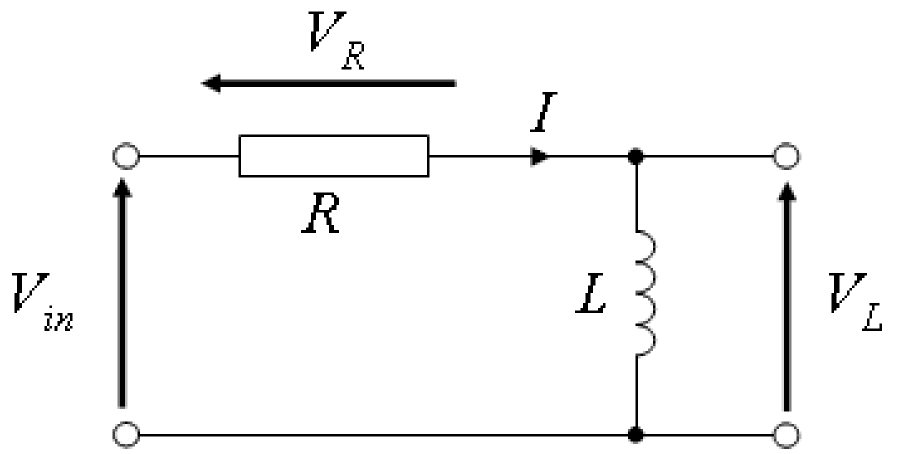
Modeling

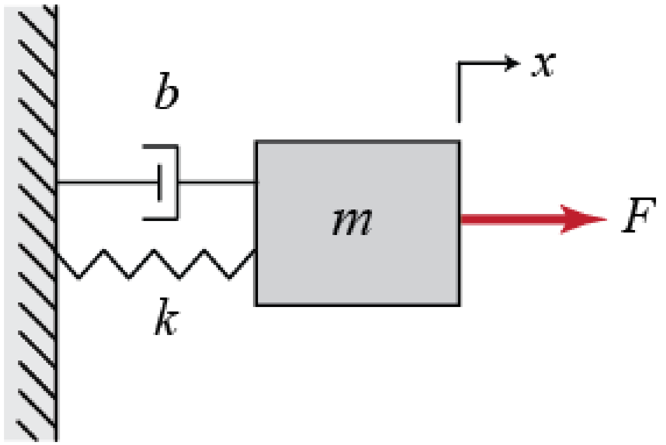
Converting behavior of objects into mathematical equations stating the relationship of system input(s) and output(s)

Examples

Mechanical : $m\ddot{x}(t) + \ c\dot{x}(t) + kx(t) = f(t)$

Electrical : $\quad L\acute{i}\,(t) + Ri(t) = v(t)$





Lab 1

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TRANSFER FUNCTION

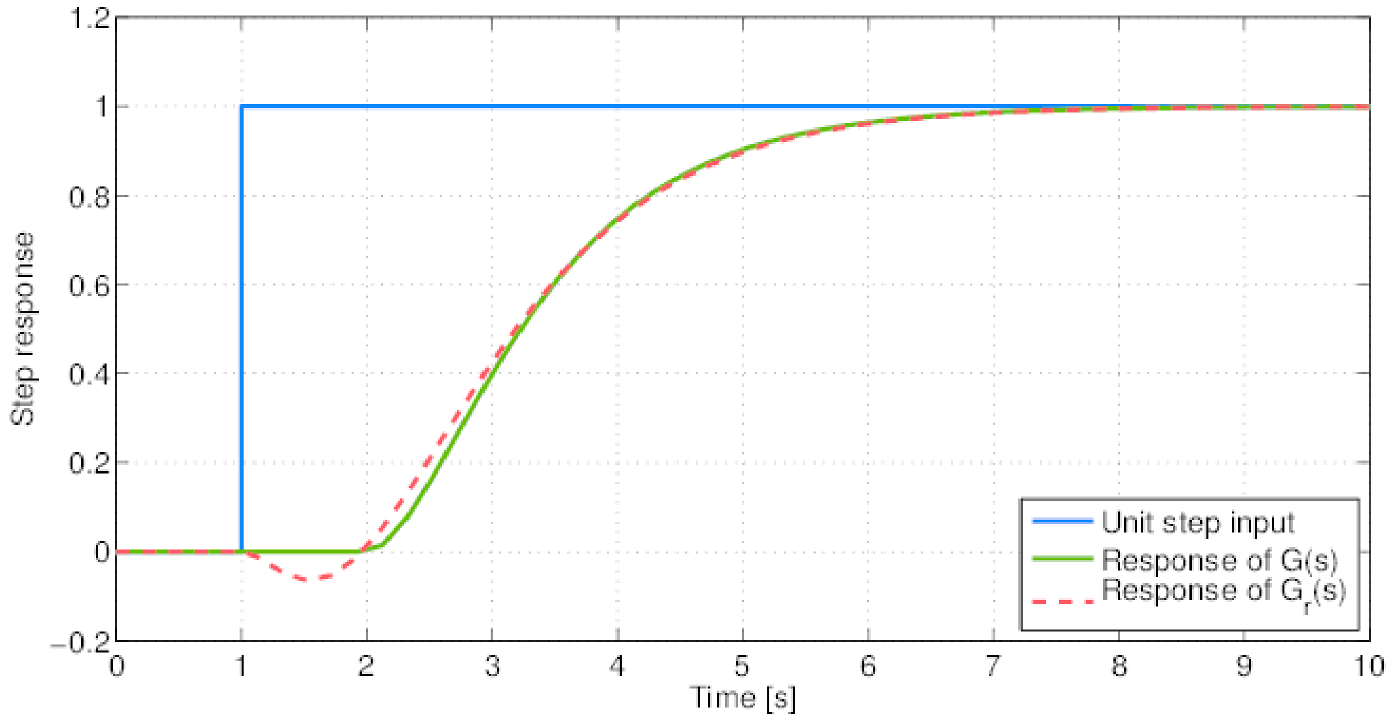
Lab 1

Quick review on concepts

Mechatronics notation

Simulation

Plotting the output(s) when the model is stimulated by an input

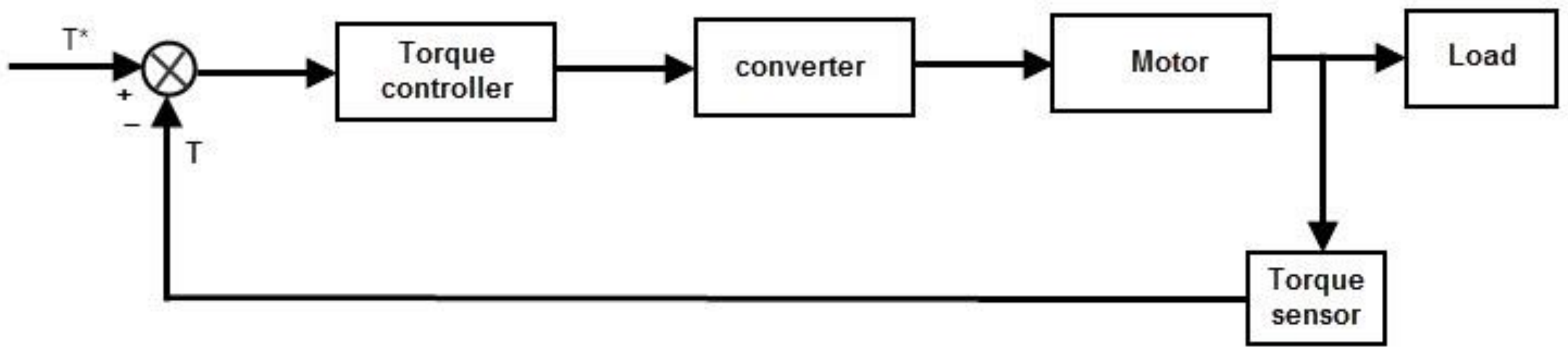


Quick review on concepts

Mechatronics notation

Control

Forcing an output to reach a desired level based on knowing the error in reading and desired input



Lab 1

Modeling of the tank

Simple example

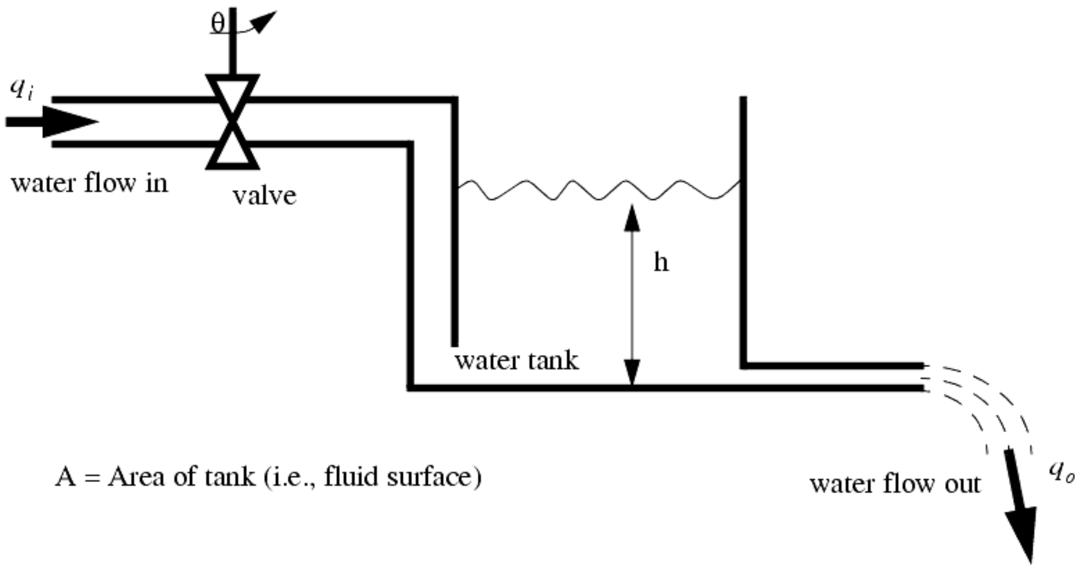
$We\ will\ ignore\ input\ valve\ (for\ simplification)$

$$\Delta V = q_o - q_i$$

$$A\frac{h(t) - h(t-\Delta t)}{t - (t - \Delta t)} = q_o - q_i$$

$$q_o = kh(t-\Delta t)$$

$$h(t) = \frac{\Delta t * (kh(t-\Delta t) - q_i)}{A} + h(t-\Delta t)$$



Lab 1

Modeling of the tank

Simple example

$$\Delta V = q_i - q_o$$

$$A\frac{h(t) - h(t - \Delta t)}{t - (t - \Delta t)} = q_i - q_o$$

$$q_o = kh(t - \Delta t)$$

$$\boxed{h(t)} = \boxed{\frac{\Delta t * (q_o - q_i)}{A}} + \boxed{h(t - \Delta t)}$$

dh

Previous State

q_i ...Tank input flowrate $(\frac{m^3}{s})$

q_o ...Tank output flowrate $(\frac{m^3}{s})$

h ...Tank height (m)

A ...Tank cross sectional area (m^2)

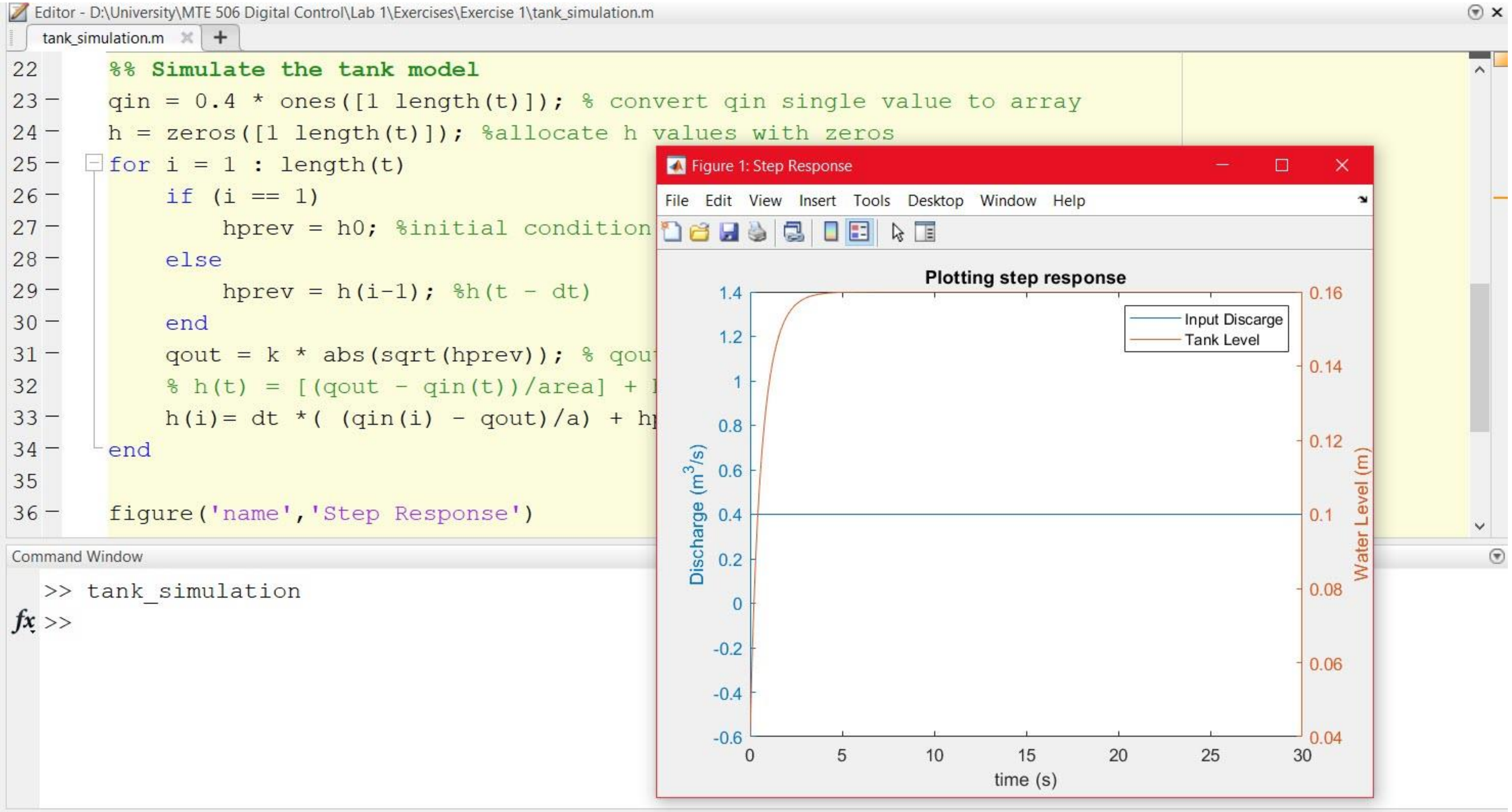
k ...friction coefficient $(\frac{m^2}{2})$

Lab 1

MATLAB scripting

Exercise 1

- What is the value of qin to reach a level of 3m ?
- Will the final level be changed if K is changed ?

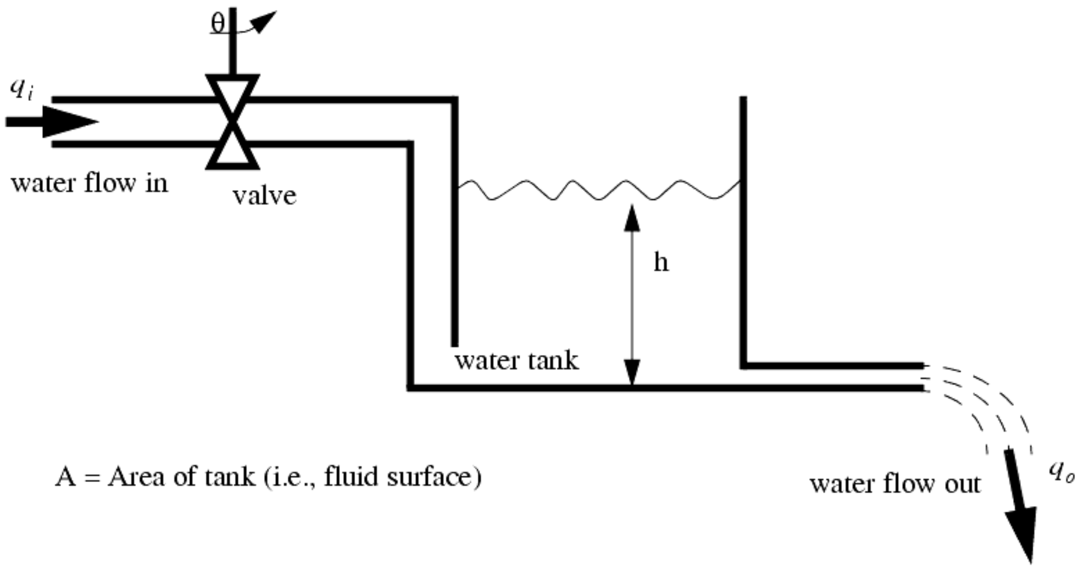


Lab 1

Modeling of the tank

Laplace Transform

We will ignore input valve (for simplification)



$$\Delta V = q_i - q_o$$

$$A\frac{h(t) - h(t-\Delta t)}{t-(t-\Delta t)} = q_i - q_o$$

$$A\frac{dh}{dt} = q_i - kh$$

$$A\frac{dh}{dt} + kh = q_i \qquad \frac{A}{k}\frac{dh}{dt} + h = \frac{q_i}{k} \qquad \tau\frac{dh}{dt} + h = K_2 q_i$$

Lab 1

Modeling of the tank

Laplace Transform

$$\Delta V = q_i - q_o$$

$$A \frac{h(t) - h(t - \Delta t)}{t - (t - \Delta t)} = q_i - q_o$$

$$A \frac{dh}{dt} = q_i - kh$$

$$A \frac{dh}{dt} + kh = q_i \qquad \frac{A}{k}\frac{dh}{dt} + h = \frac{q_i}{k}$$

$$\boxed{\tau = \frac{A}{k} \qquad K_2 = \frac{1}{k}}$$

$$\frac{H(s)}{Q_i(s)} = \frac{K_2}{\tau S + 1}$$

First Order System

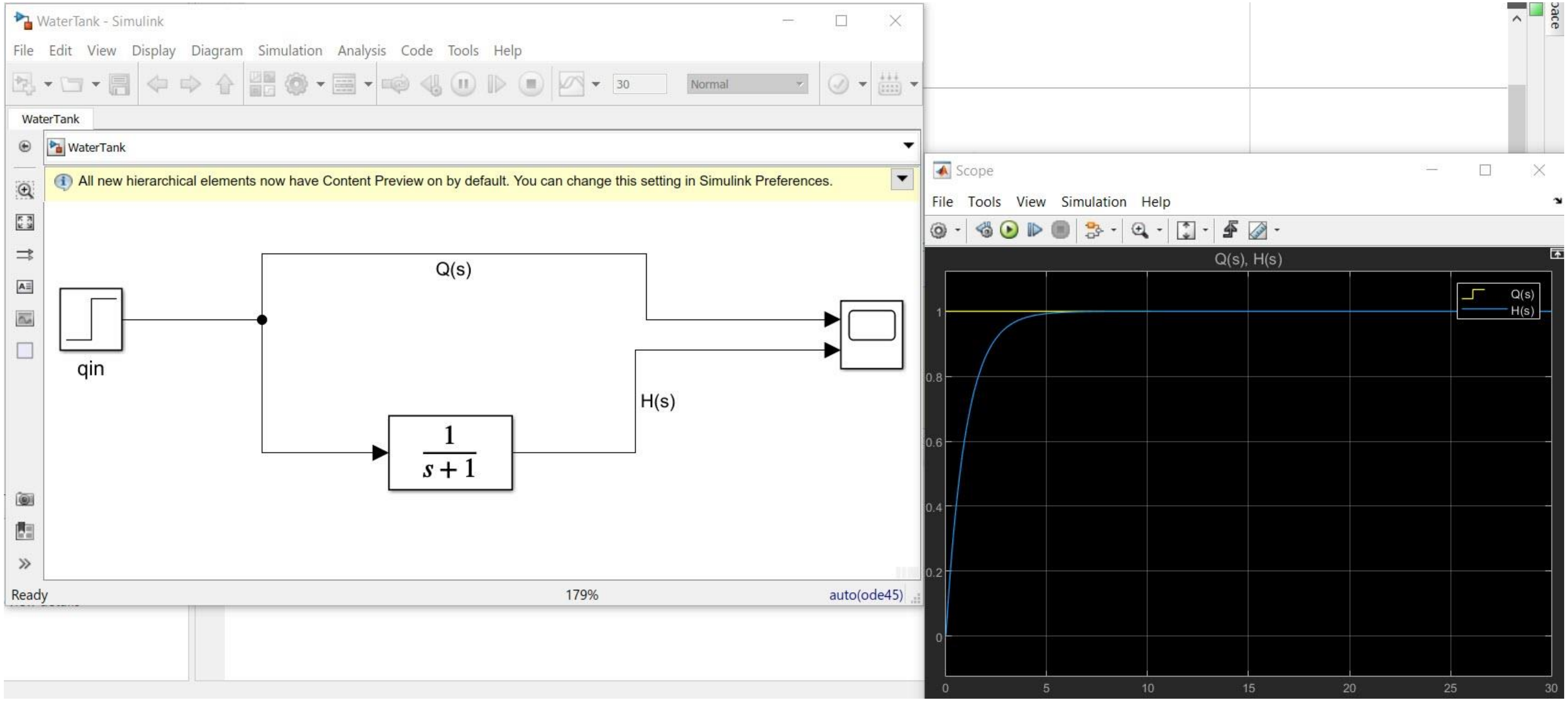
$$\boxed{\tau \frac{dh}{dt} + h = K_2 q_i}$$

Lab 1

SIMULINK

Exercise 2

- What is the value of qin to reach a level of 3m ?
- Will the final level be changed if K is changed ?



END OF LAB 1