Homework 2
– parameter estimation

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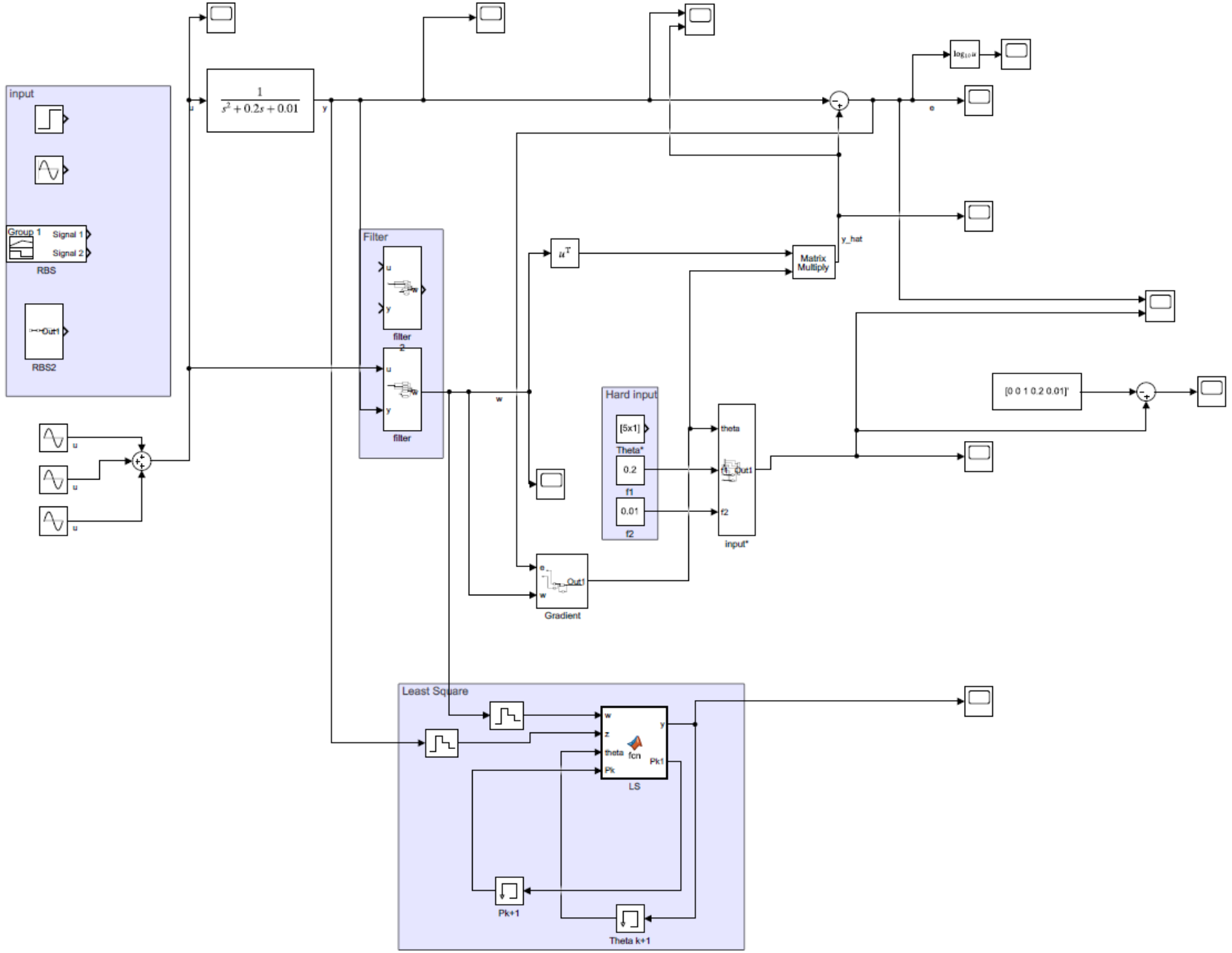
Overview

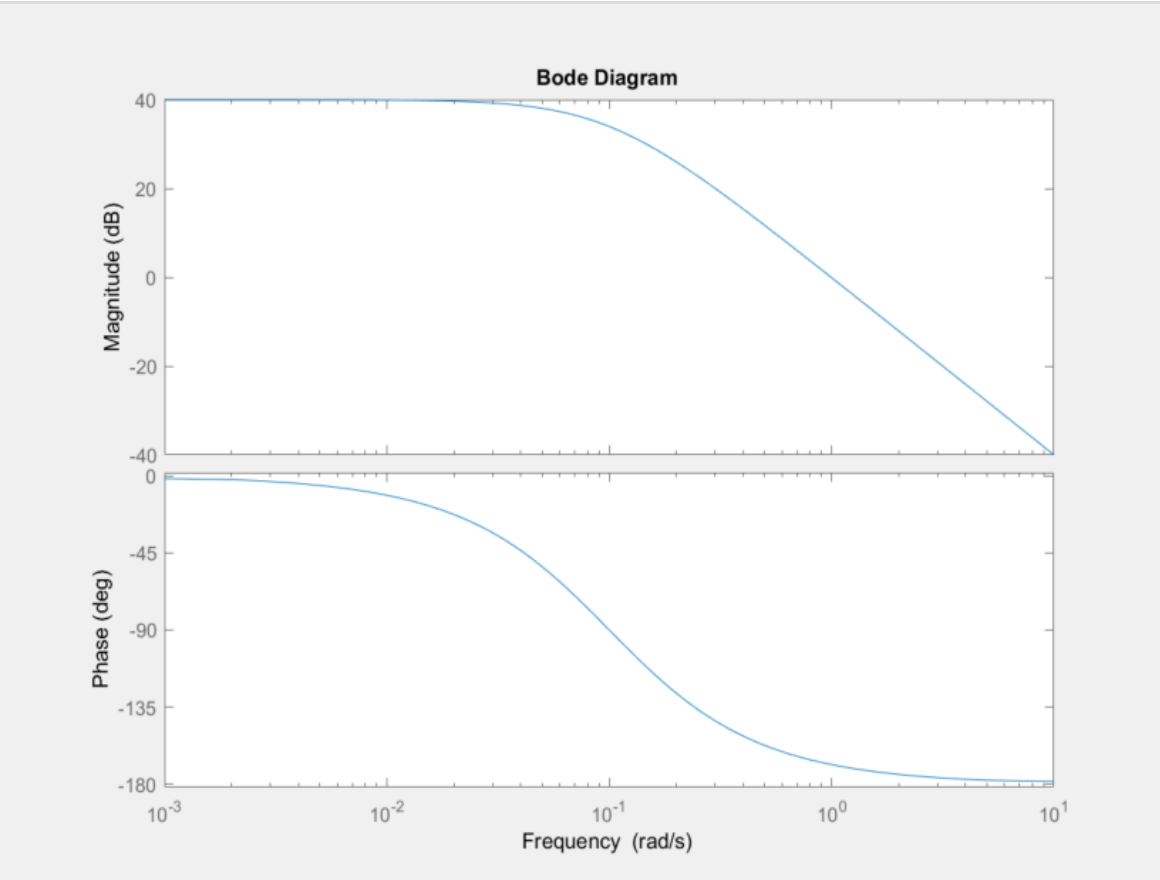
- System setup
- Plant 1 without PE
- Plant 1 with PE
- Plant 2 without PE
- Plant 2 with PE

Setup

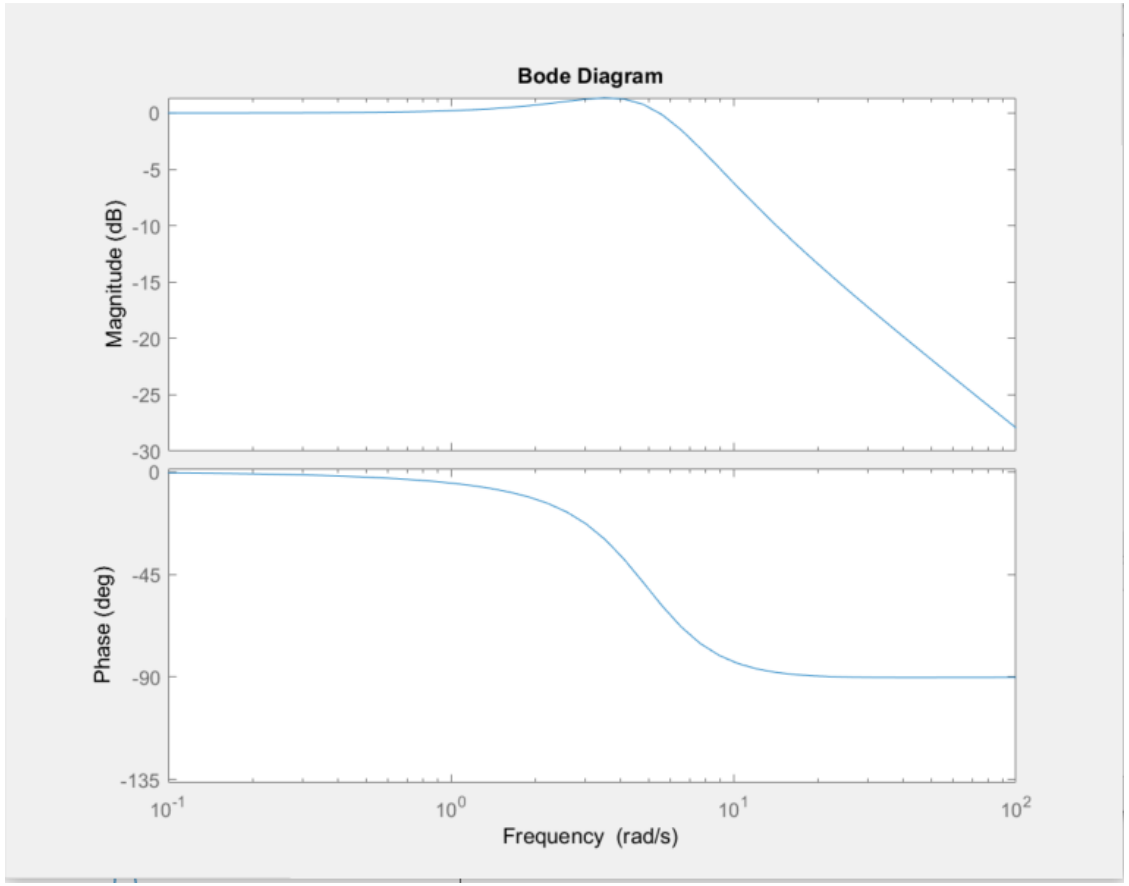

input
Group 1
Signal 1
Signal 2
RBS
Out1
RBS2
$\frac{1}{s^2+0.2s+0.01}$
u
y
Filter
filter
filter
w
u^T
Matrix Multiply
y_hat
e
$\log_{10} u$
[0 0.1 0.2 0.01]'
Hard input
[5x1]
Theta*
0.2
f1
0.01
f2
theta
Out1
input*
Gradient
Least Square
w
z
theta
Pk
fcn
y
Pk1
LS
Pk+1
Theta k+1

Bode plot

- We used Bode plot to check the frequency response for ideal filter.



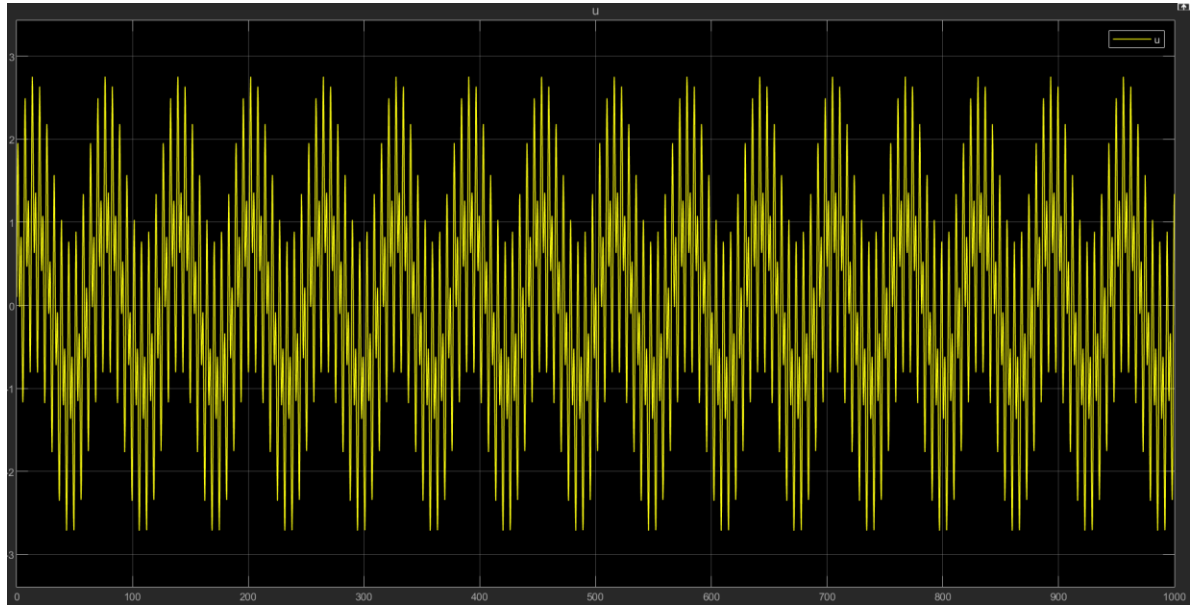
Plant 1

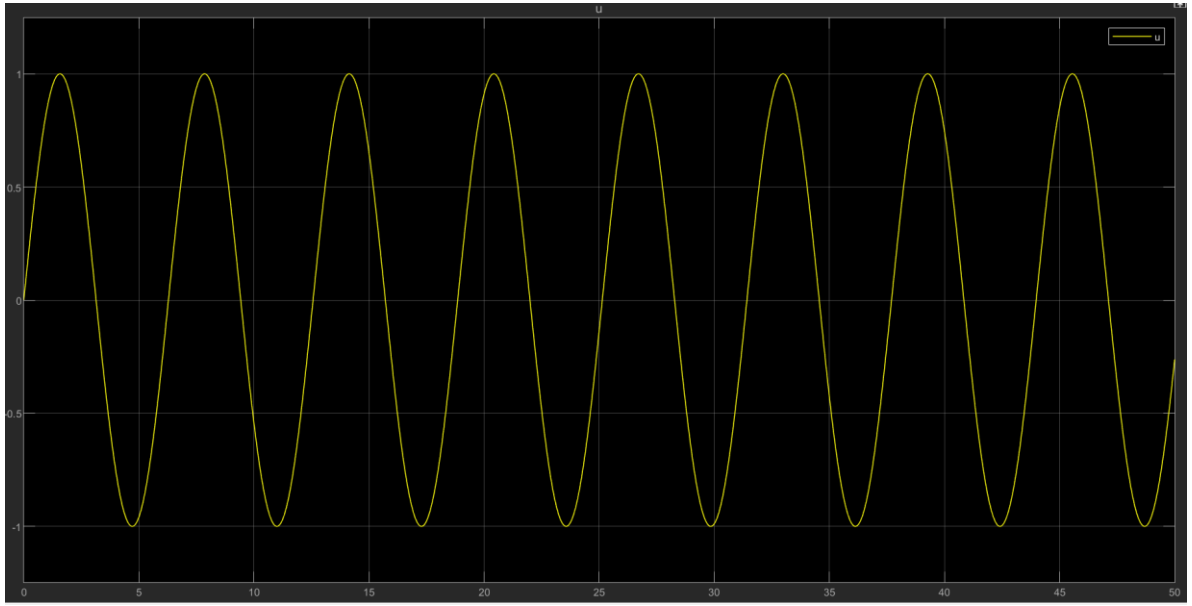


Plant 2

Inputs

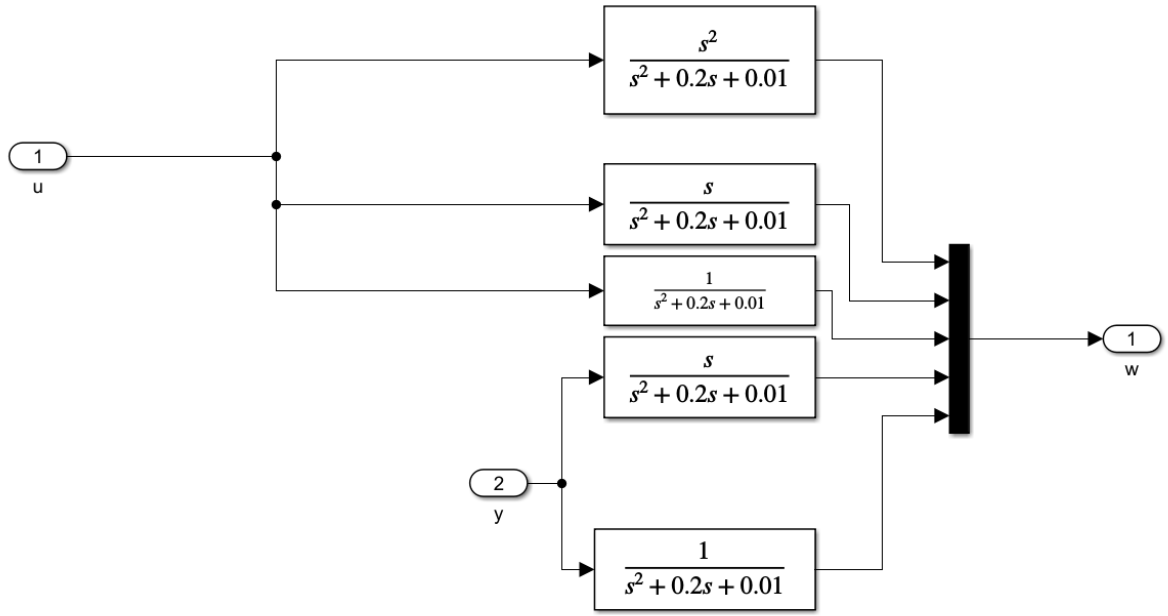
- We compare a non-PE to a PE input
- PE input: combination of sine wave at frequency of 0.1, 1, 2Hz
- Non-PE input: sine wave at frequency of 0.1Hz





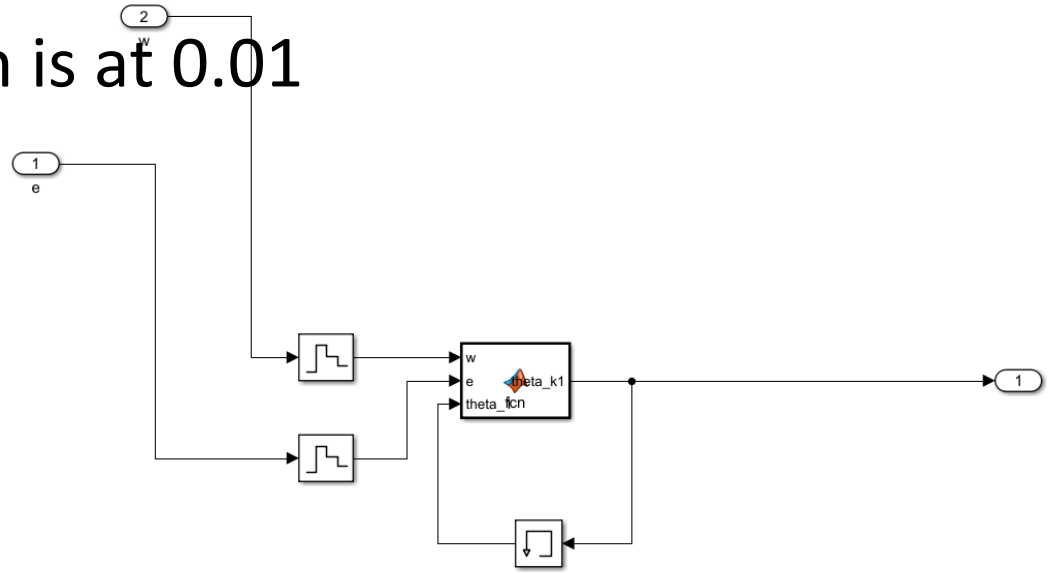
Filter

- A good filter would be stabilizing as well as having bandwidth close to the bandwidth of the plant
- In this case, we use the denominator of the plant as filter



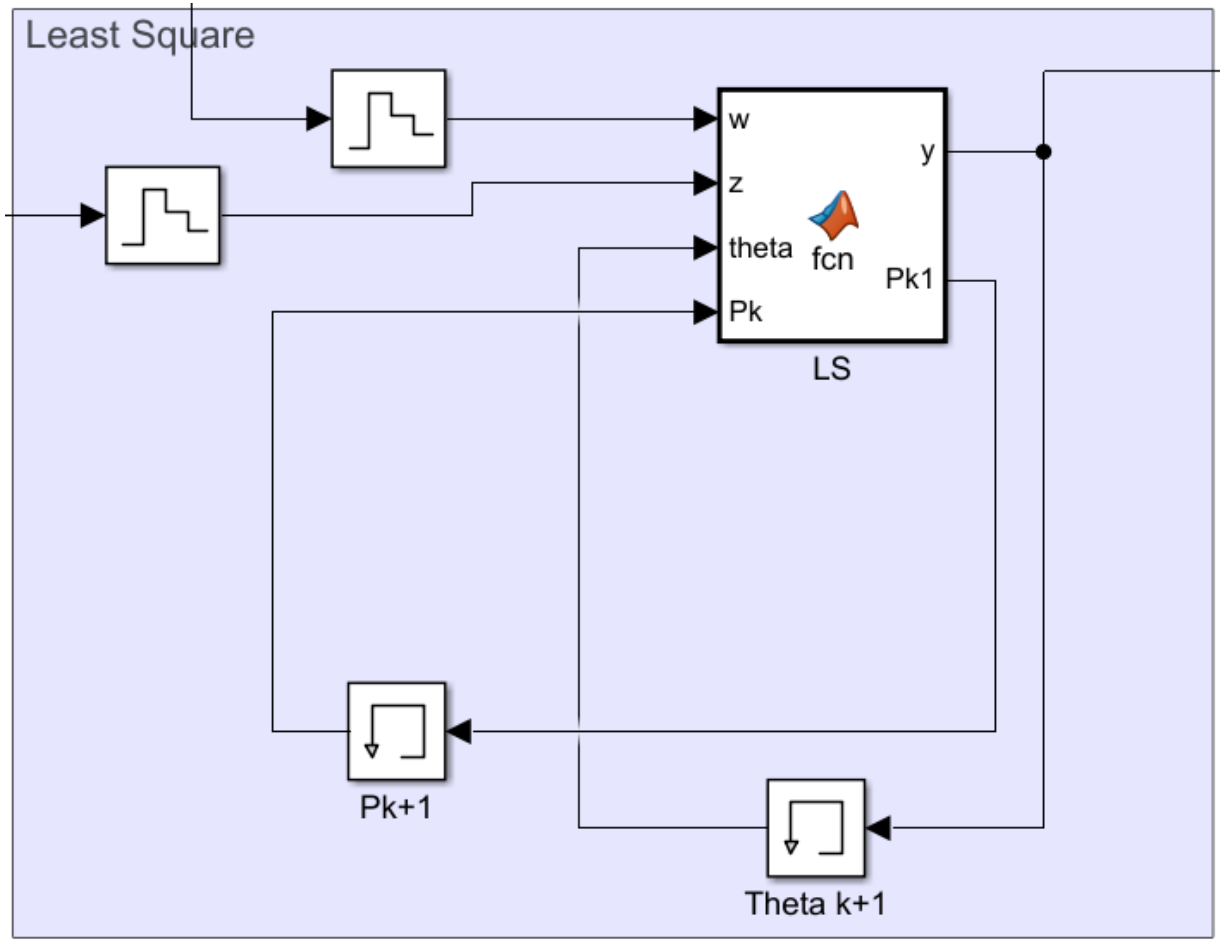
Gradient

- We set the initial condition to be very close to actual plant, with 10^{-6} and 0.1 difference for plant 1
- Initial error is set to 1 for plant 2
- Gamma is set to 0.000001 for plant 1, 10 for plant 2
- Sampling speed for discrete time system is at 0.01

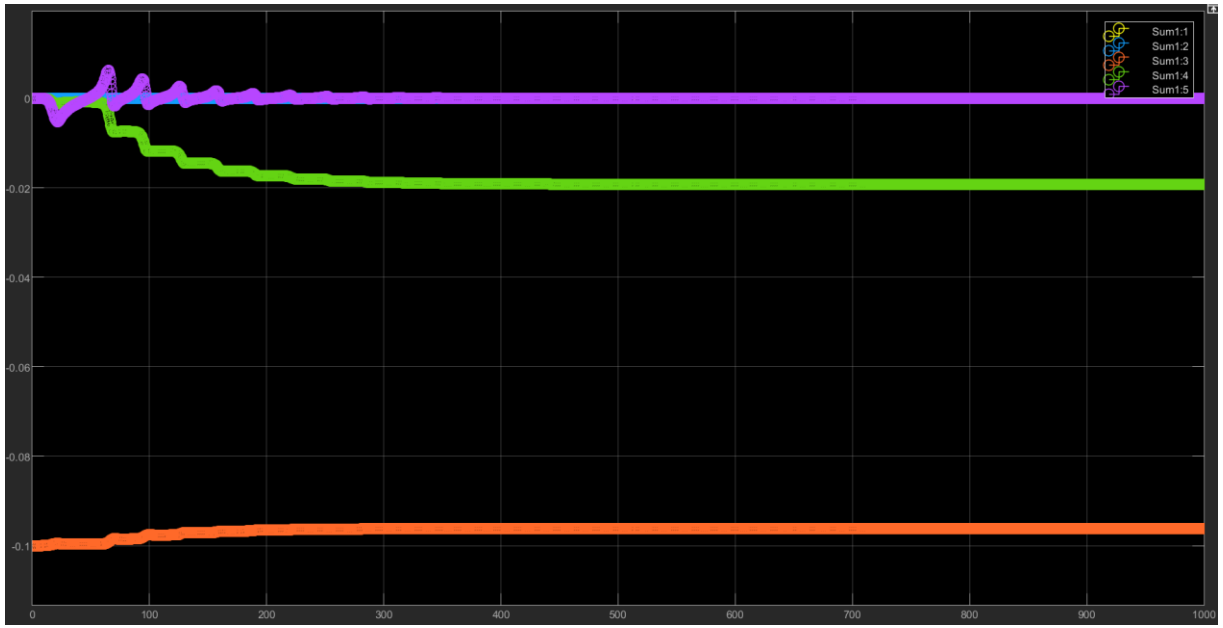


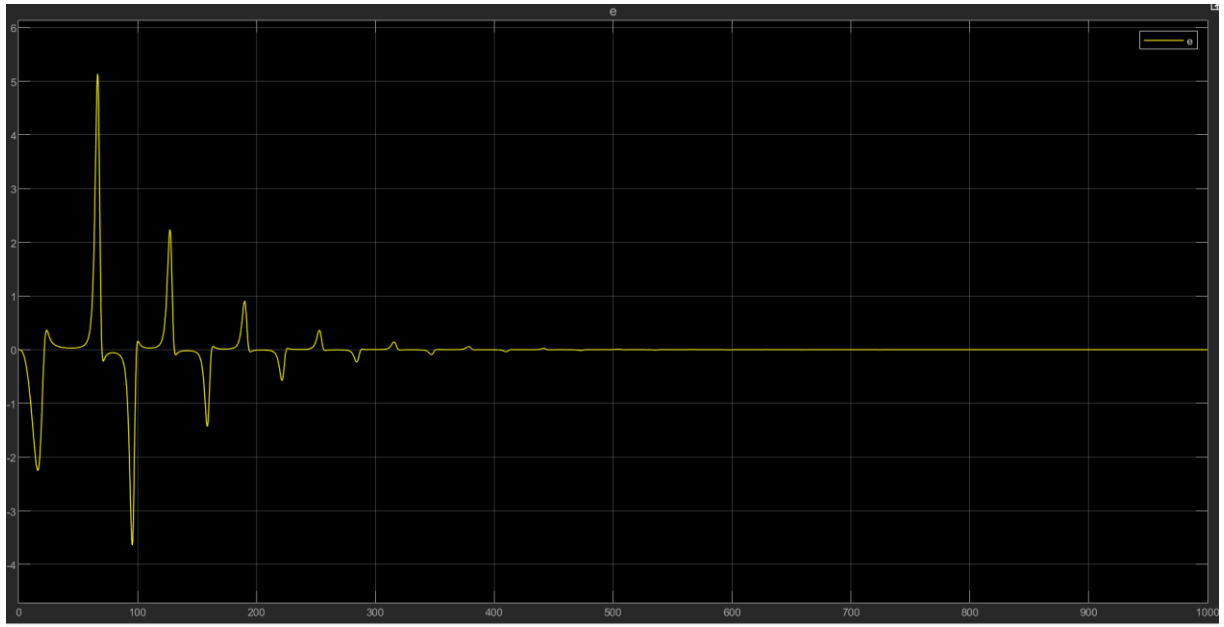
Least square

- We set initial values to be all zero
- Alpha/gamma is set to 1

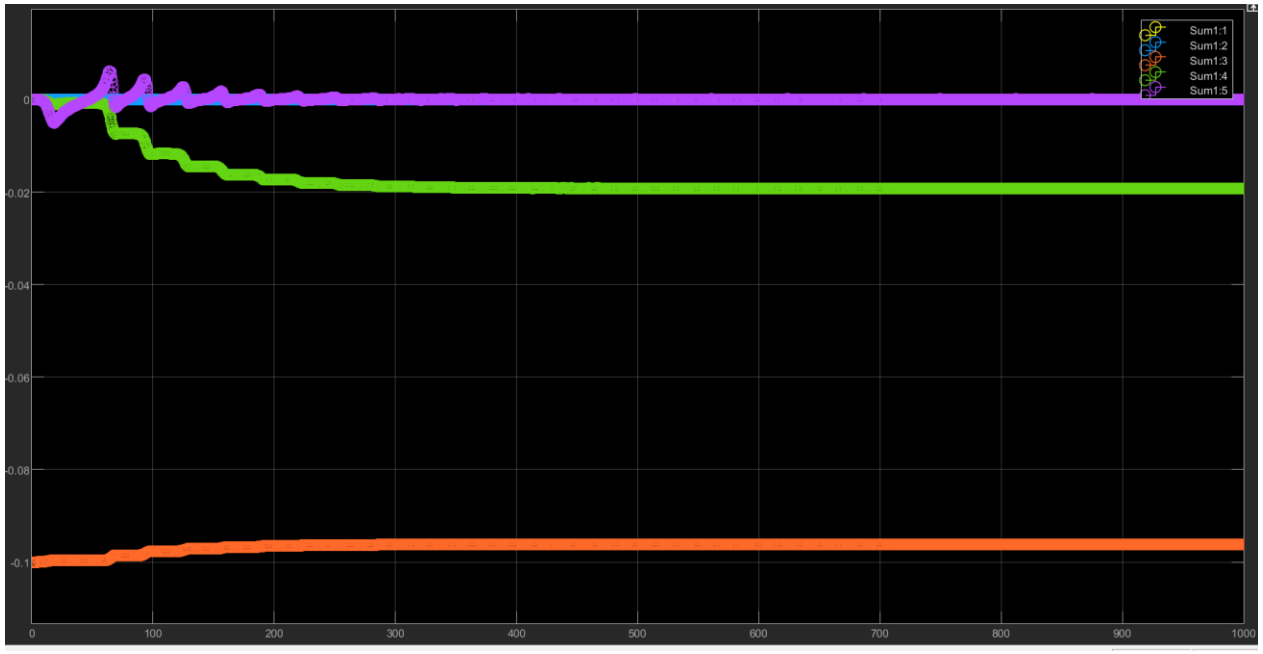


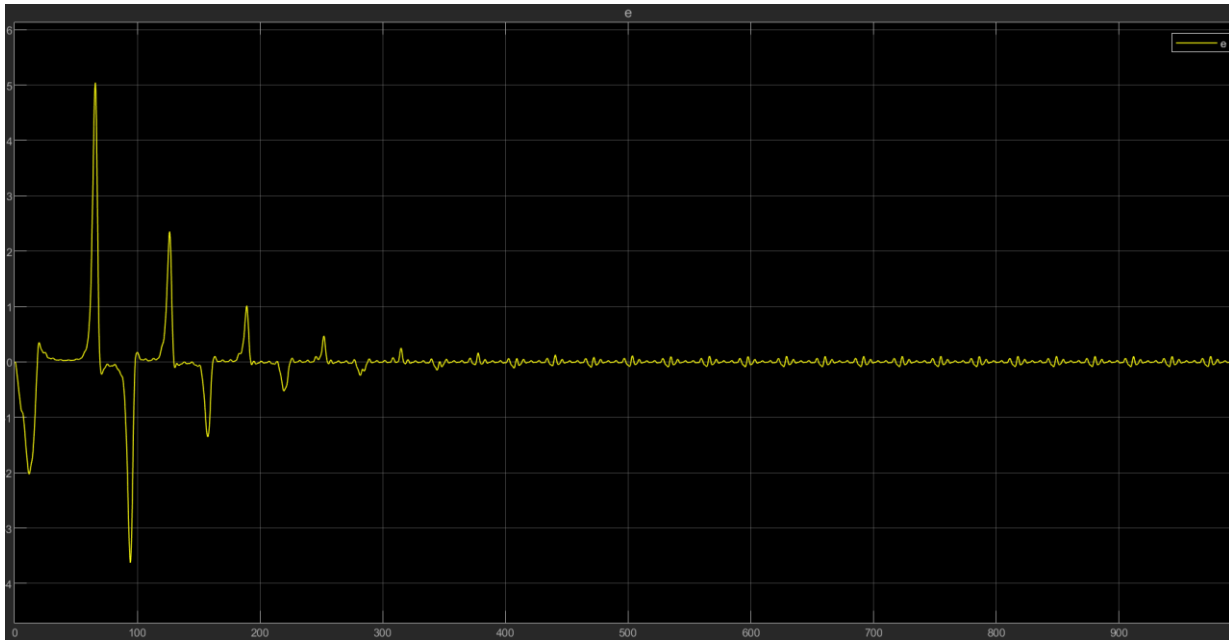
Plant 1 without PE - Gradient



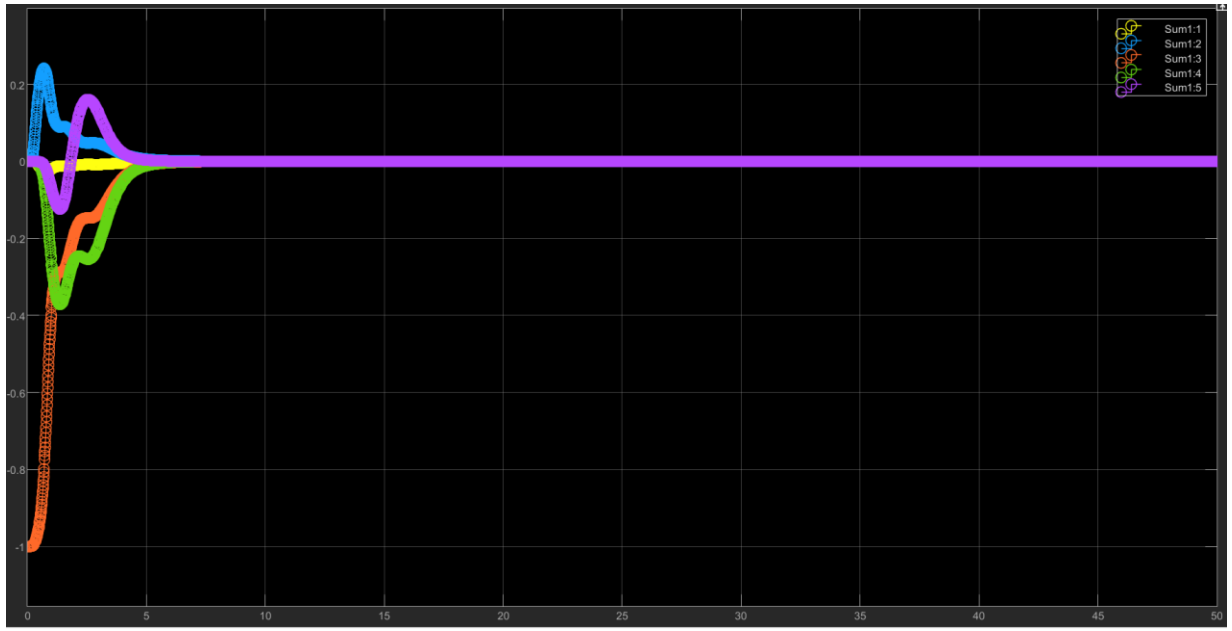


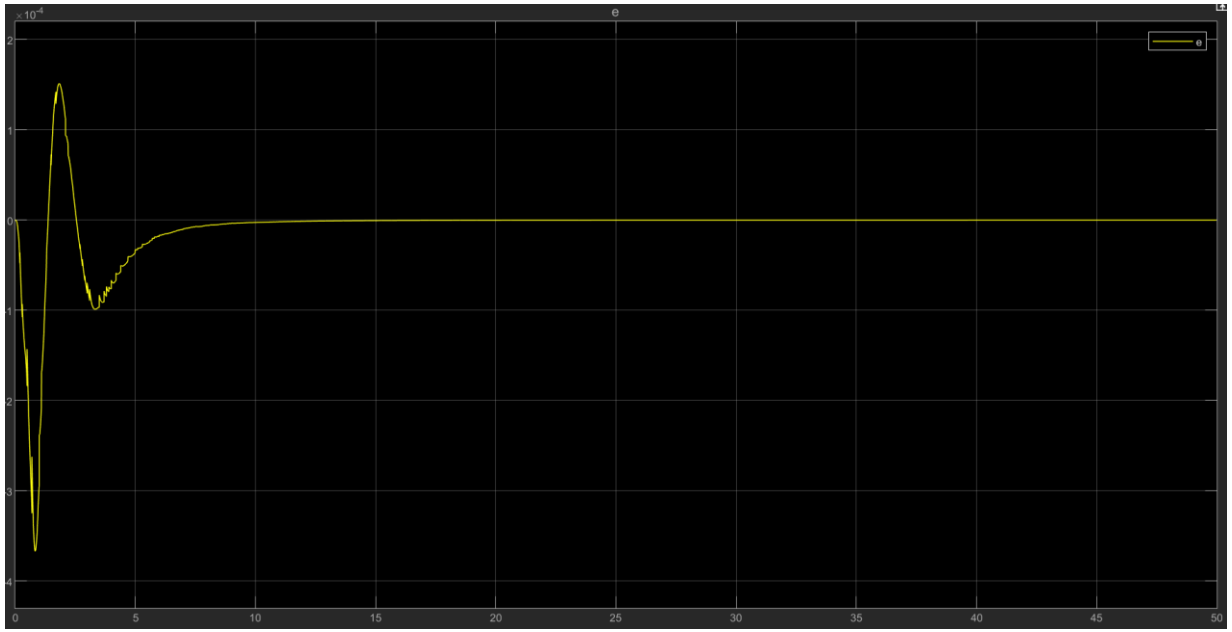
Plant 1 with PE - Gradient



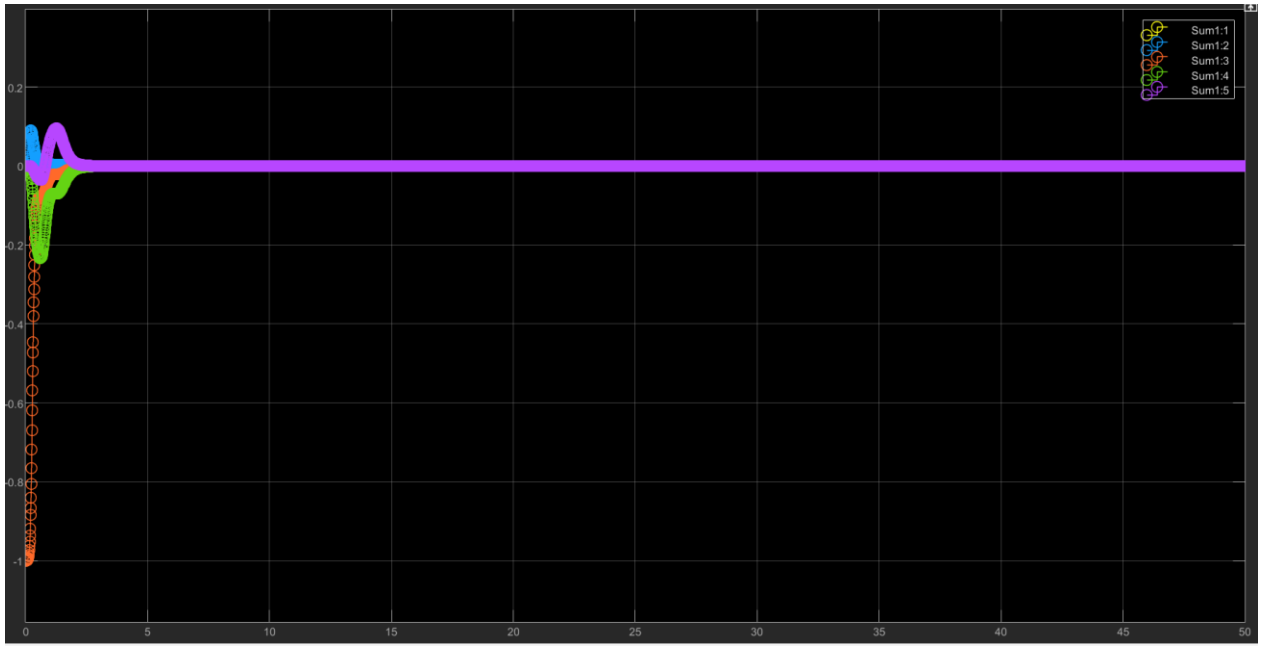


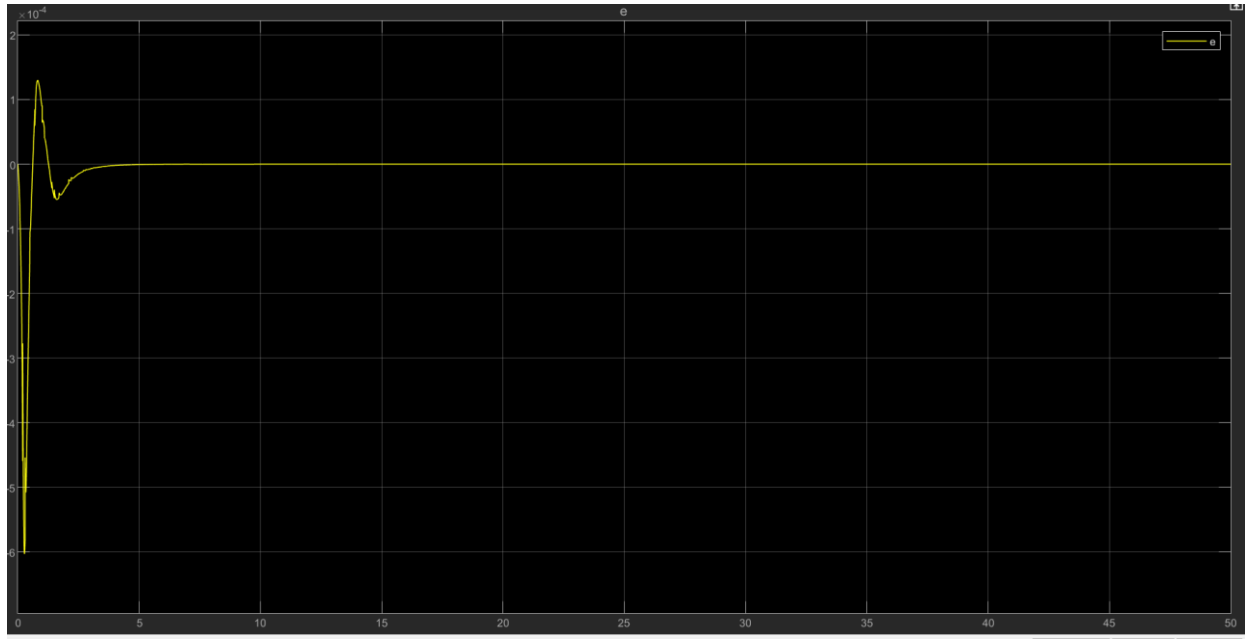
Plant 1 without PE - LS





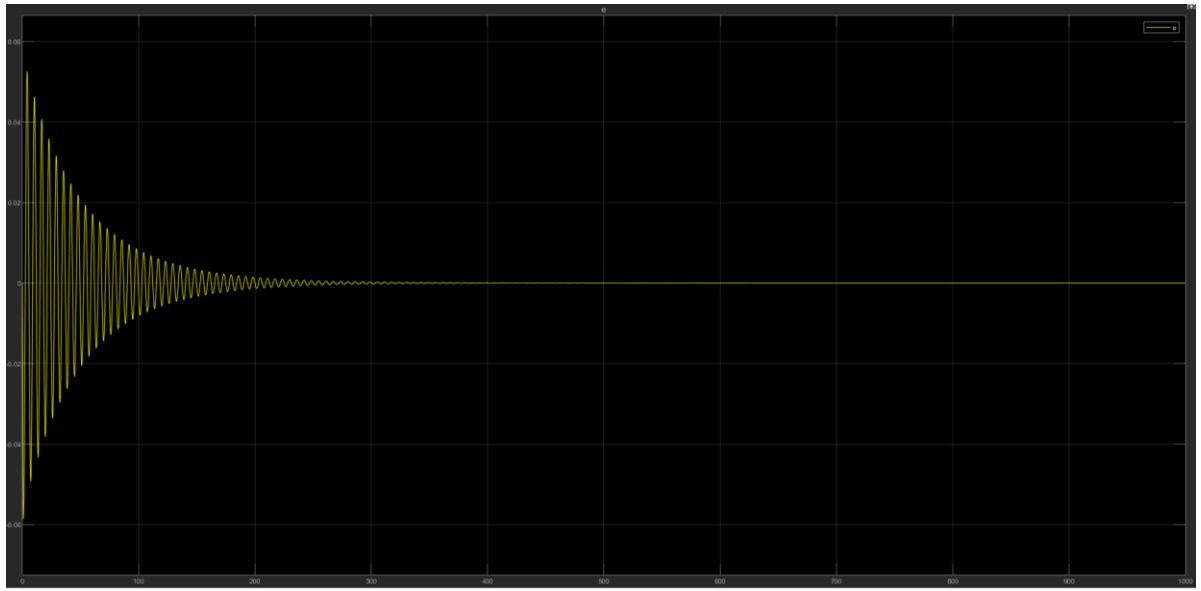
Plant 1 with PE - LS

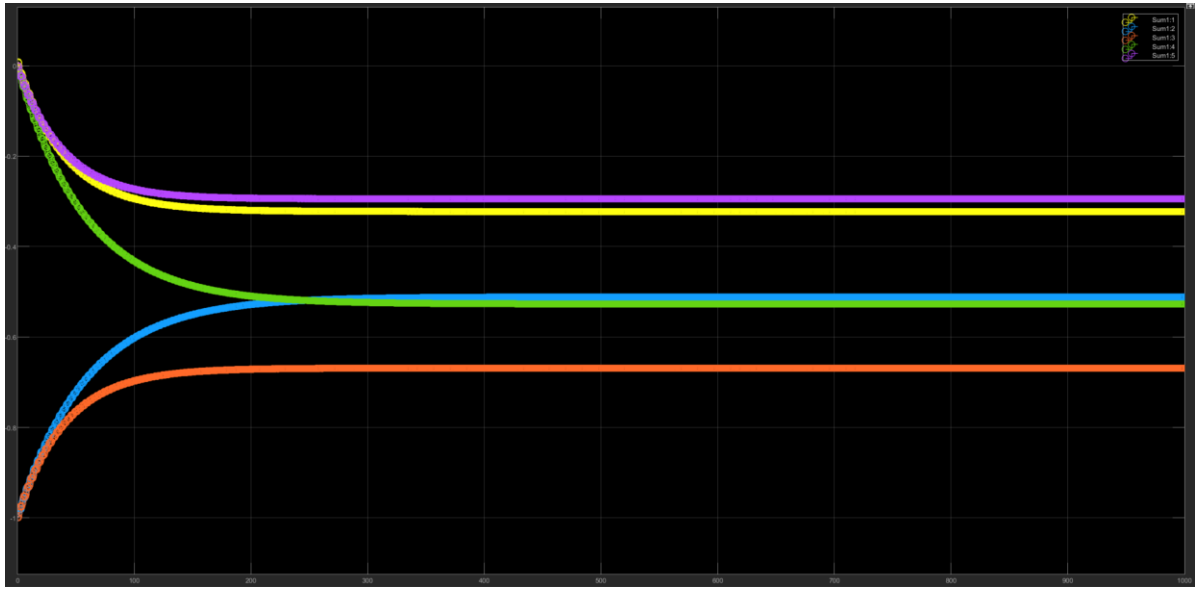




Plant 2 without PE - Gradient

- T = 1000s, initial = [0 3 24 0 0]’, gamma = 10





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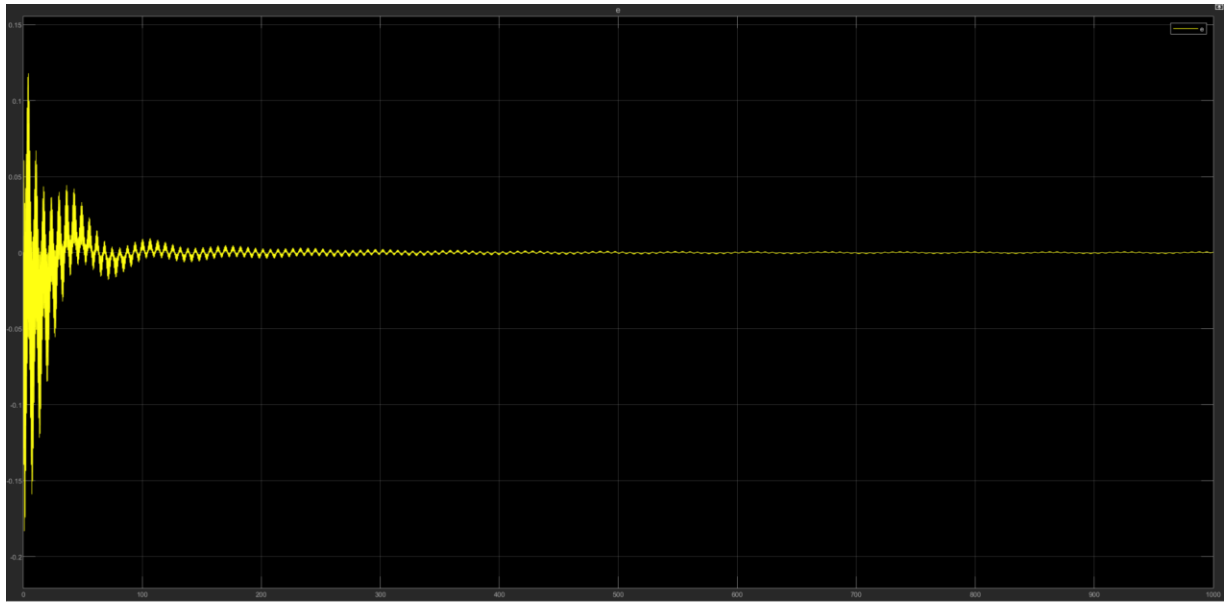
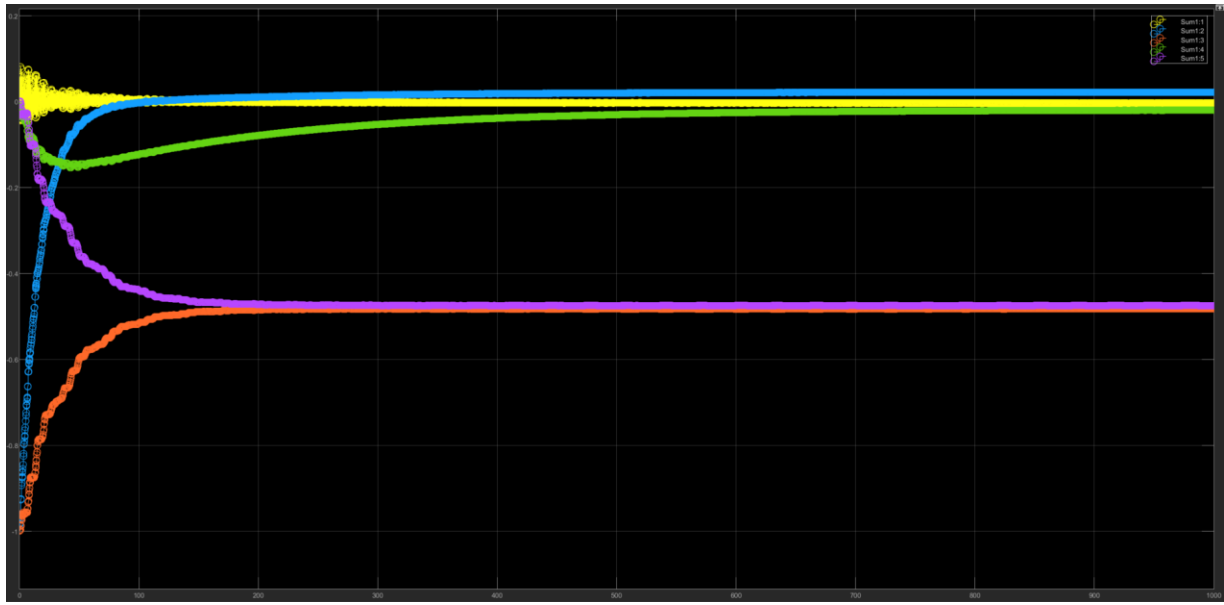
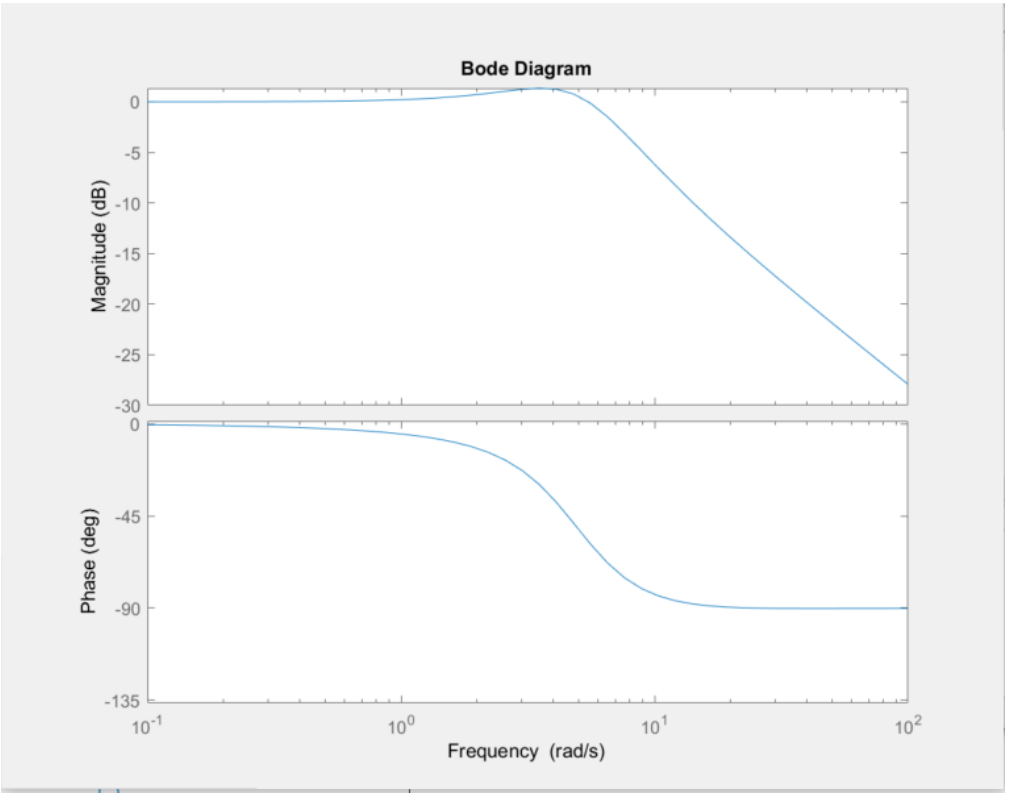
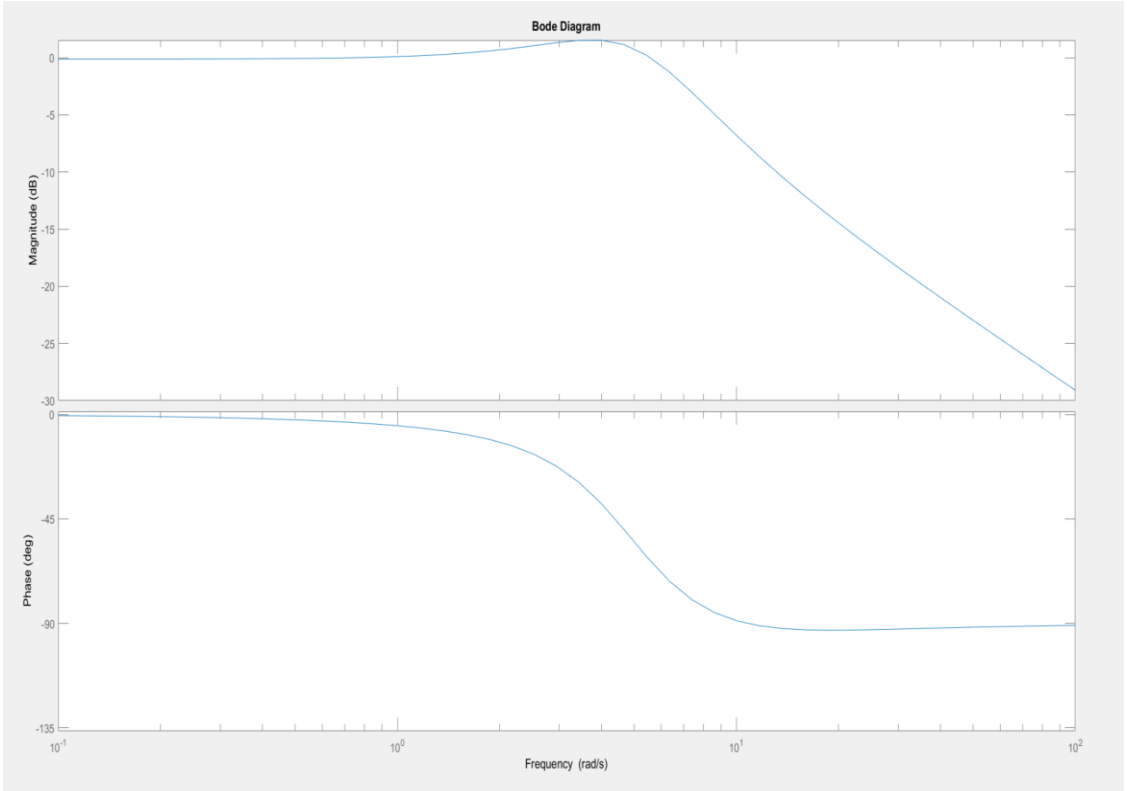




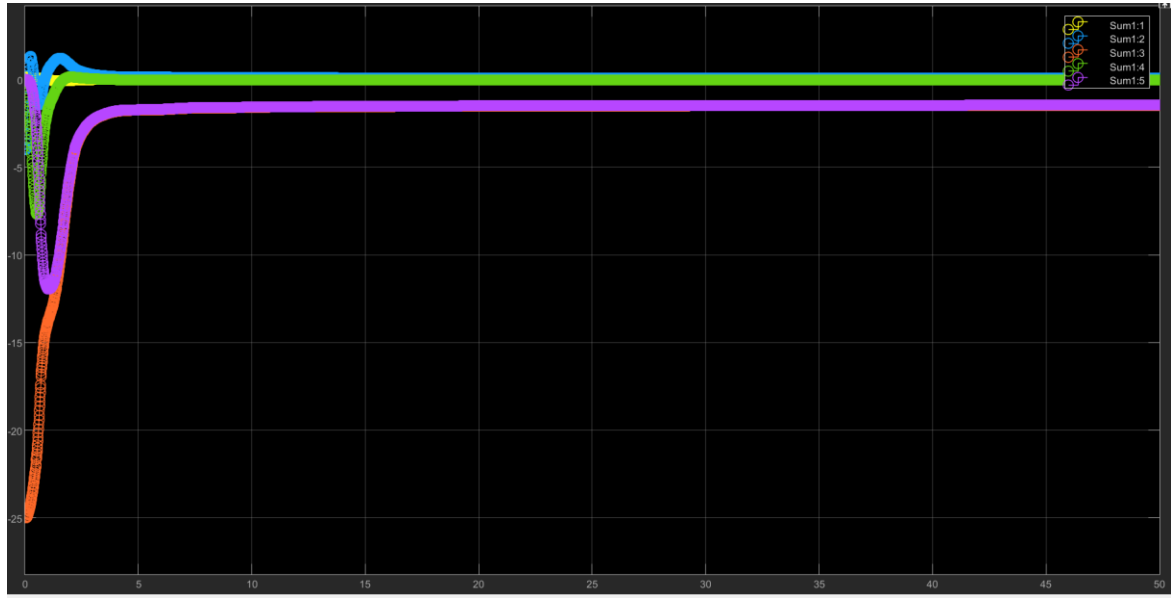
Plant 2 – Gradient – bode plot

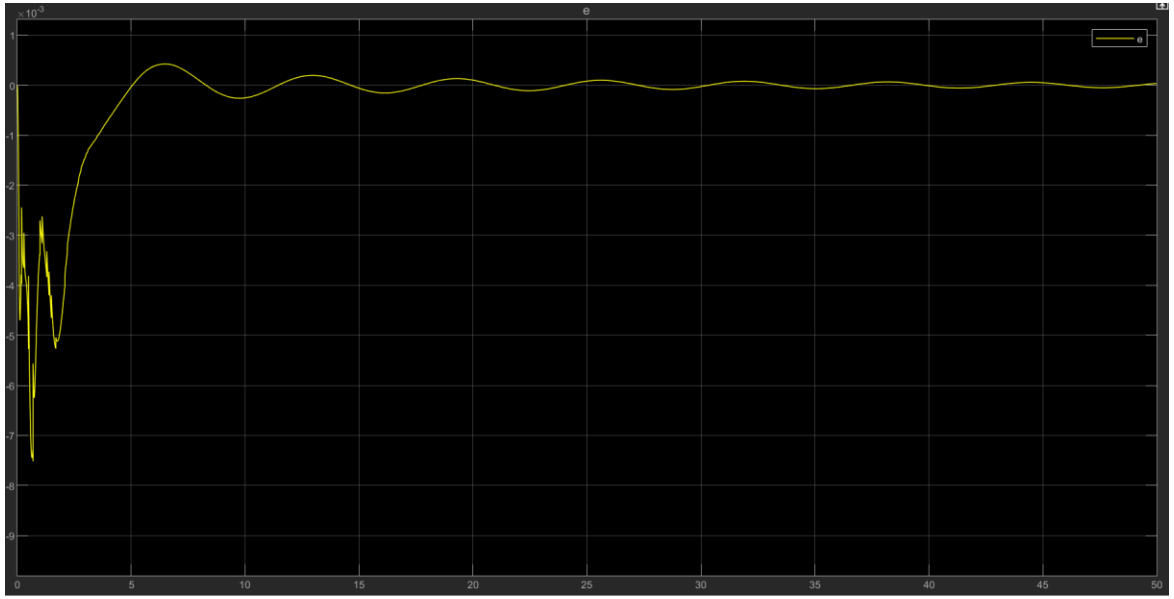
- Since the parameter error is significant, we performed bode plot analysis to compare the response of 2 systems





Plant 2 without PE - LS





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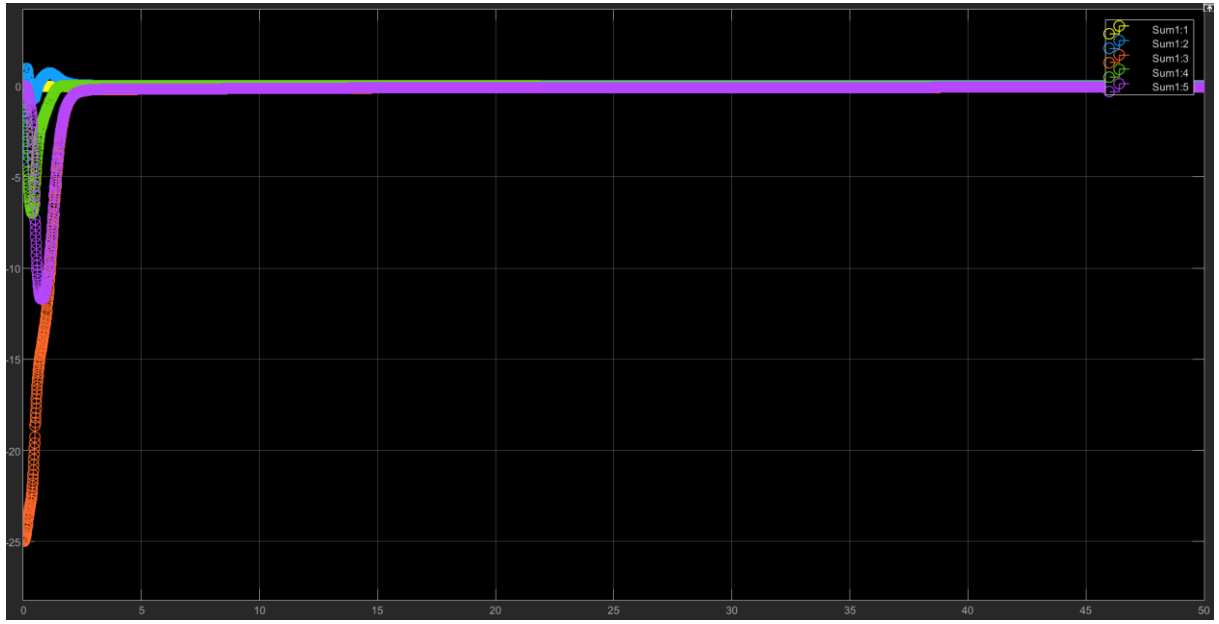

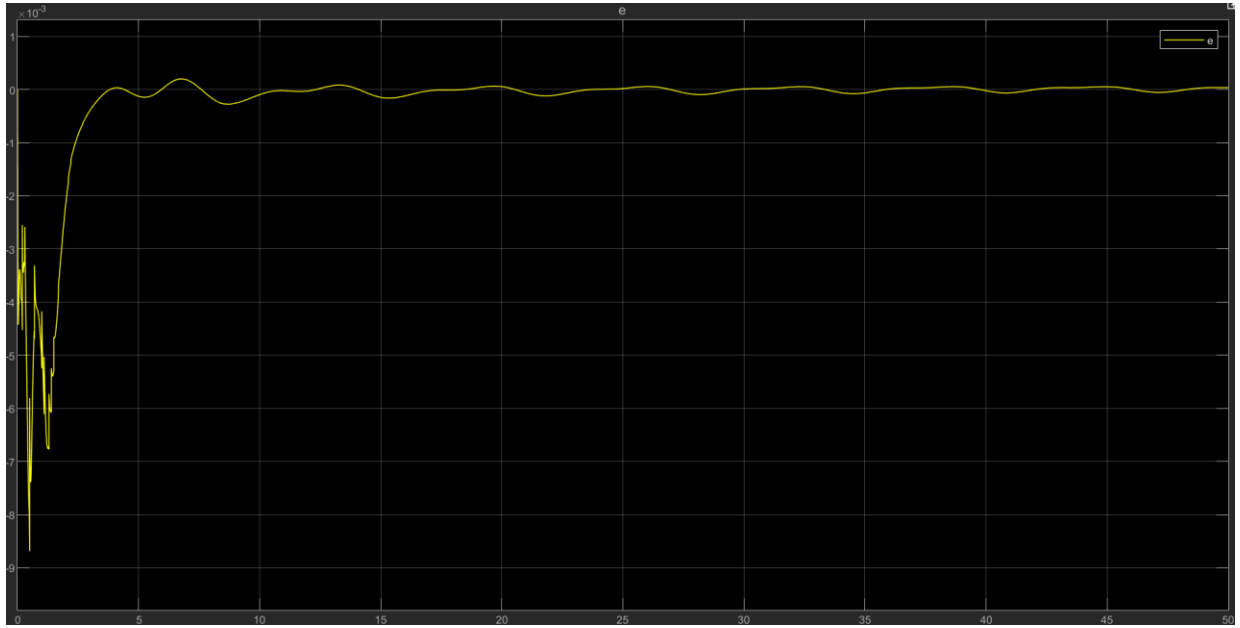

Summary

- In general, LS has better adapting speed than gradient
- Given a bigger error in initial condition, LS can adapt to it significantly faster
- Persistent excitation helps the estimation to converge to the right value, as seen in the plant 2 with LS