Practical Assignment № 3

Optimal Control

variant number : 6

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Optimal observer (Kalman filter)

1. experimental values（Group 6）

- experimental values

№	A, b	W	V
6	$\begin{bmatrix} 0 & -6 \\ 1 & -1 \end{bmatrix}$ $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 5 & 3 \\ 3 & 5 \end{bmatrix}$	1

2. Based on the known matrices A, b, shown in the table, matrix $C = [1 \quad 0]$, matrix $G = I$, and also W и V calculate the matrix L.

calculation MATLAB codes：

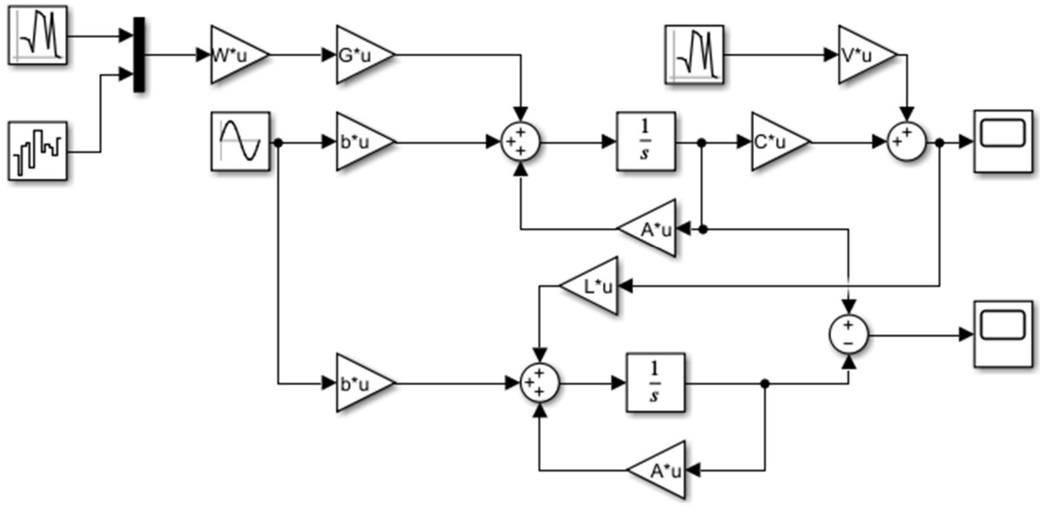
```
% Kalman filter
clear all
A = [0 -6;1 -1];b = [1;0];
C = [1 0];
W = [5 3;3 5];
V = 1;G = eye(2);
[K,P] = lqr(A',C',G*W*G',V);
L = K';
```

Calculation result(Matrix L.)

$$L = \begin{bmatrix} 3.6047 \\ -0.6661 \end{bmatrix}$$

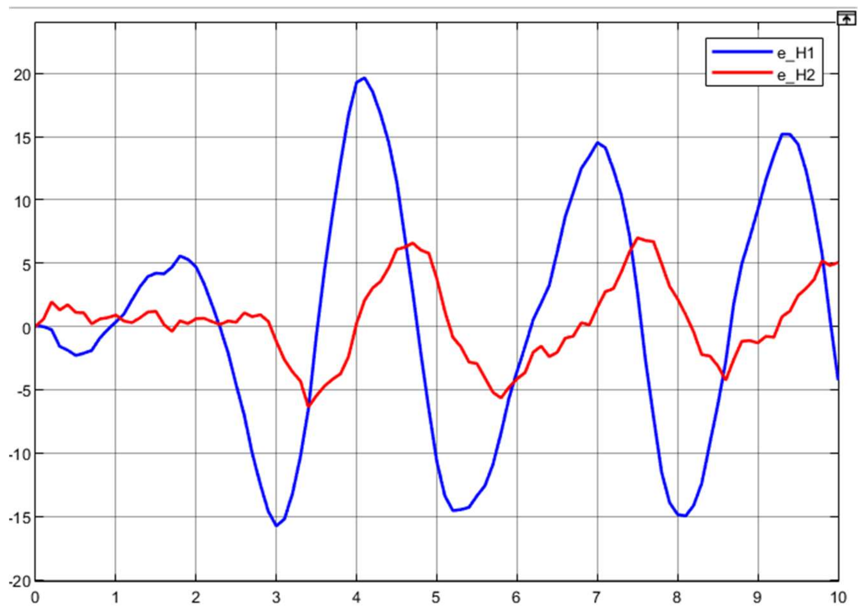
3. **Simulate a closed-loop system with initial conditions $x(0)=[1,0]^T$ and $u=sint$. Plot the variables e_{H1}, e_{H2}.**

Simulink models



Simulink Results

- variables e_{H1}, e_{H2}



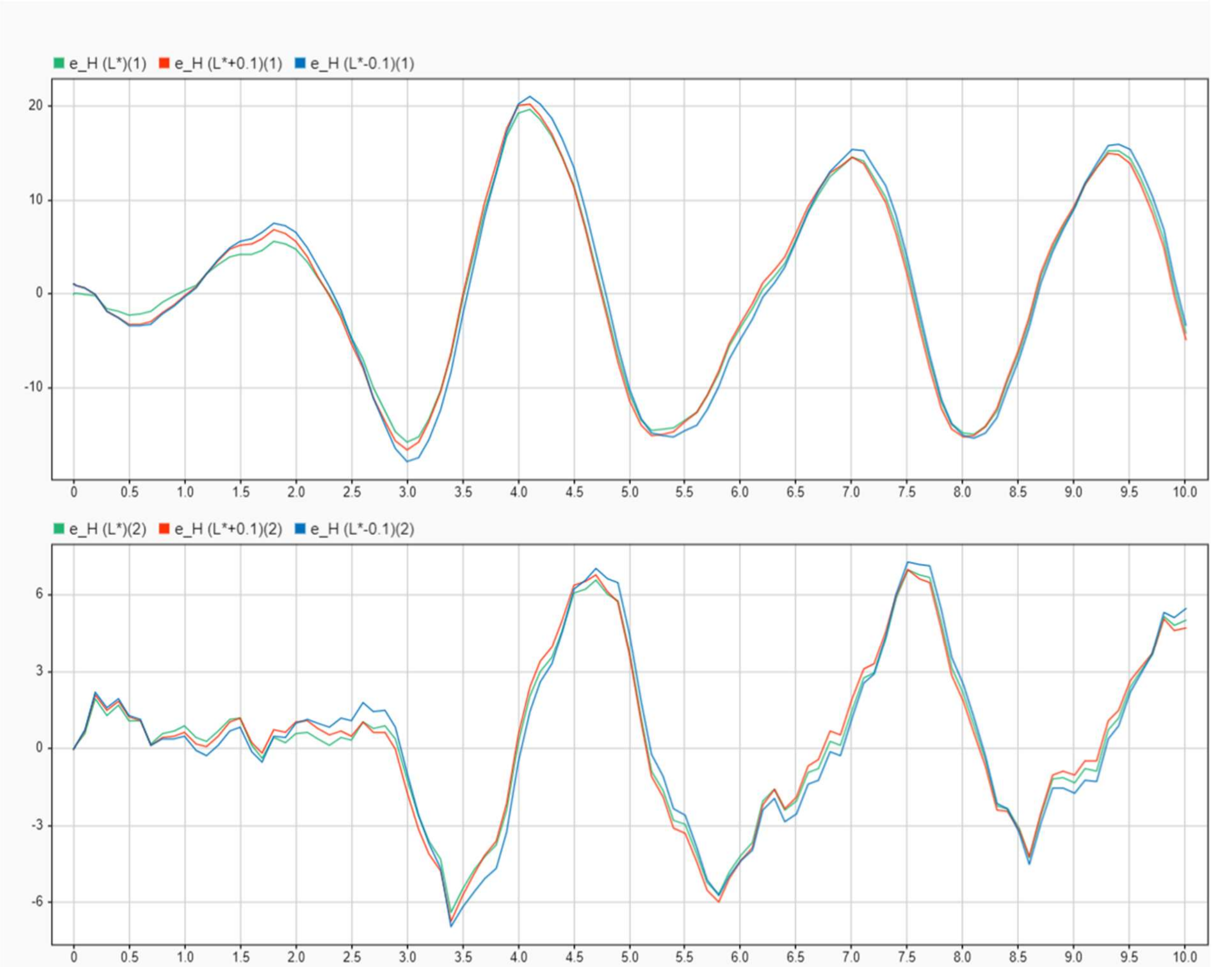
4. **Negligibly change *L* parameters so that the system preserves the stability and repeat № 2 with the same simulation time. Compare with results obtained in № 2 and make a conclusion.**

Let's change L as follows:

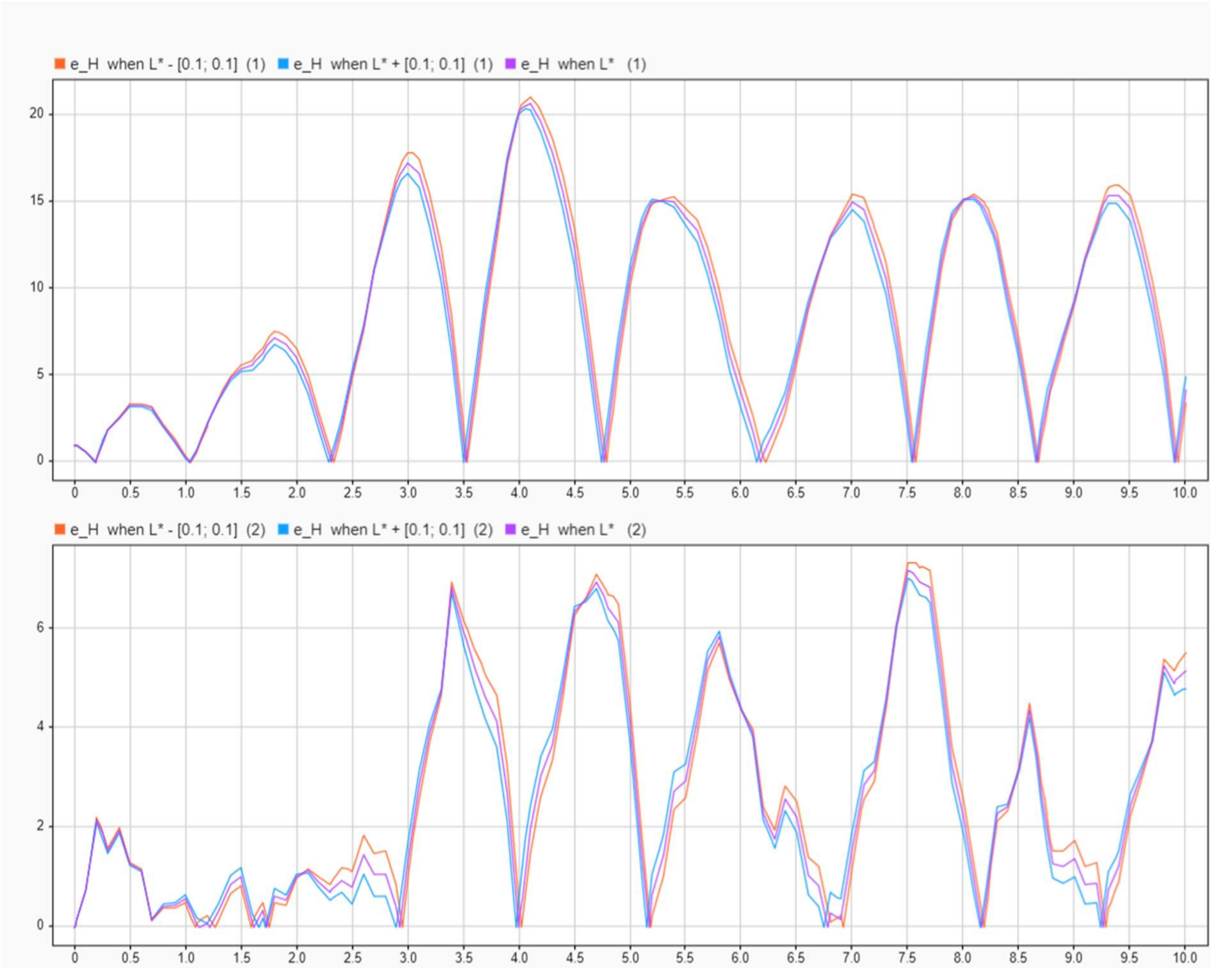
$$L = L^* - [0.1 \quad 0.1]$$
$$L = L^* + [0.1 \quad 0.1]$$

Simulation Results

- variables e_{H1}, e_{H2}



- absolute value $|e_{H1}|, |e_{H2}|$



Conclusion: Generally speaking, within limits, the smaller the L is, the bigger the observer errors are.

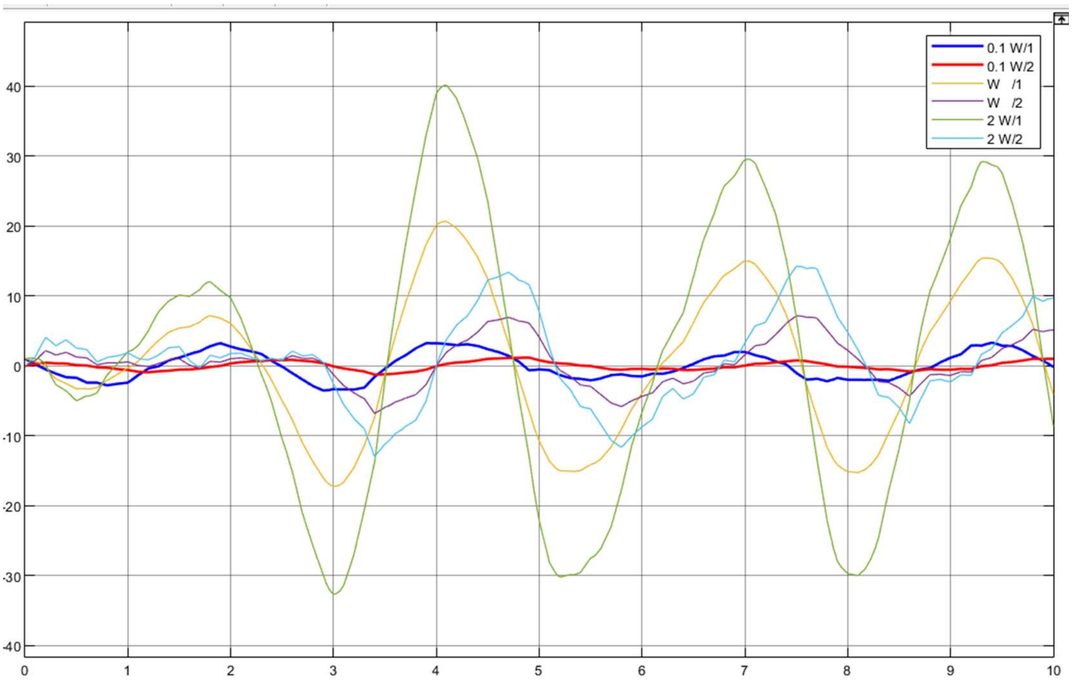
5. Change W parameters so that the matrix W remains symmetric and positive-defined and repeat № 2 with the same simulation time. Compare with results obtained in № 2 and make a conclusion.

Let's change W as follows:

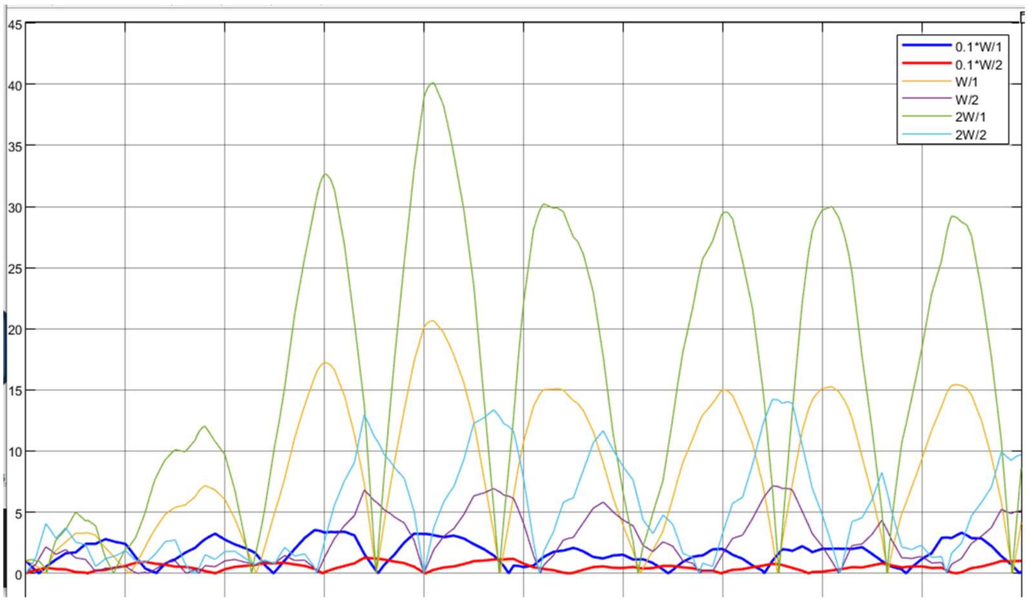
$$W = 0.1 \times W^*$$
$$W = 10 \times W^*$$

Simulation Results

- variables e_{H1}, e_{H2}



- absolute value $|e_{H1}|, |e_{H2}|$



Conclusion: Generally speaking, within limits, the larger the spectral density W is, the bigger the observer errors are.

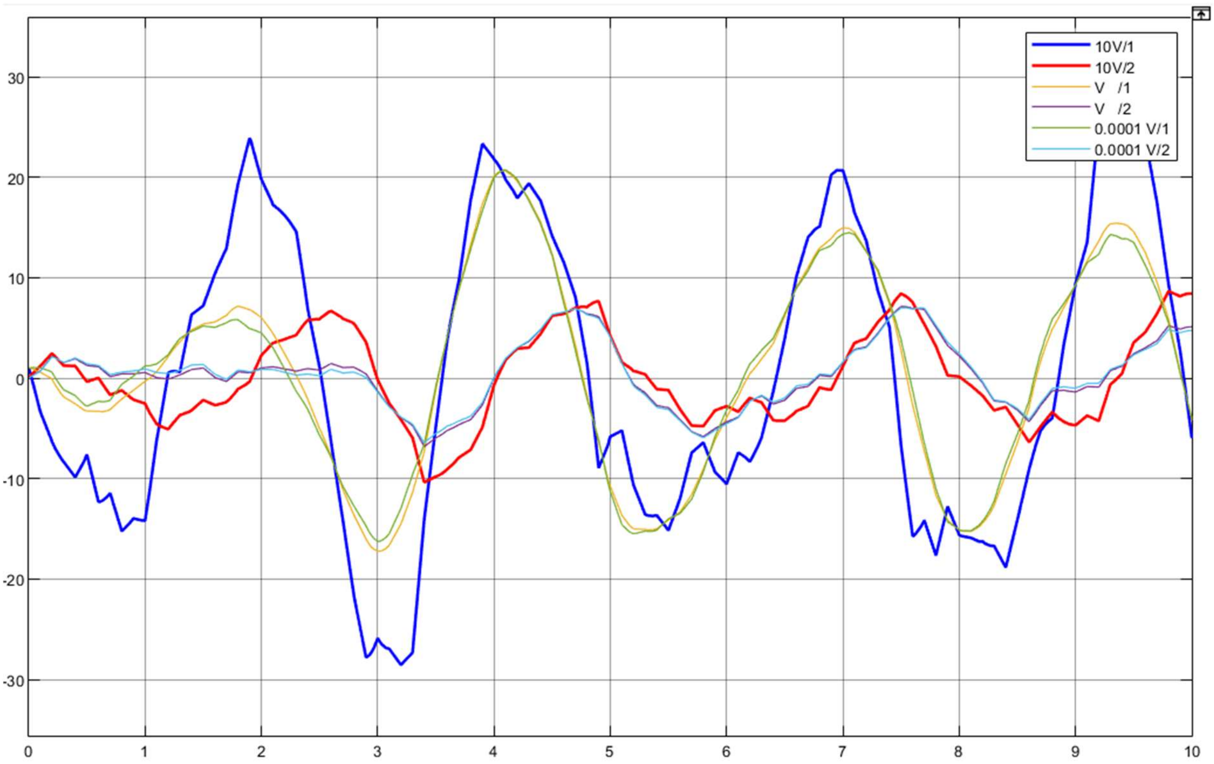
6. **Change V so that the value V remains positive and repeat № 2 with the same simulation time. Compare with results obtained in № 2 and make a conclusion.**

Let's change V as follows:

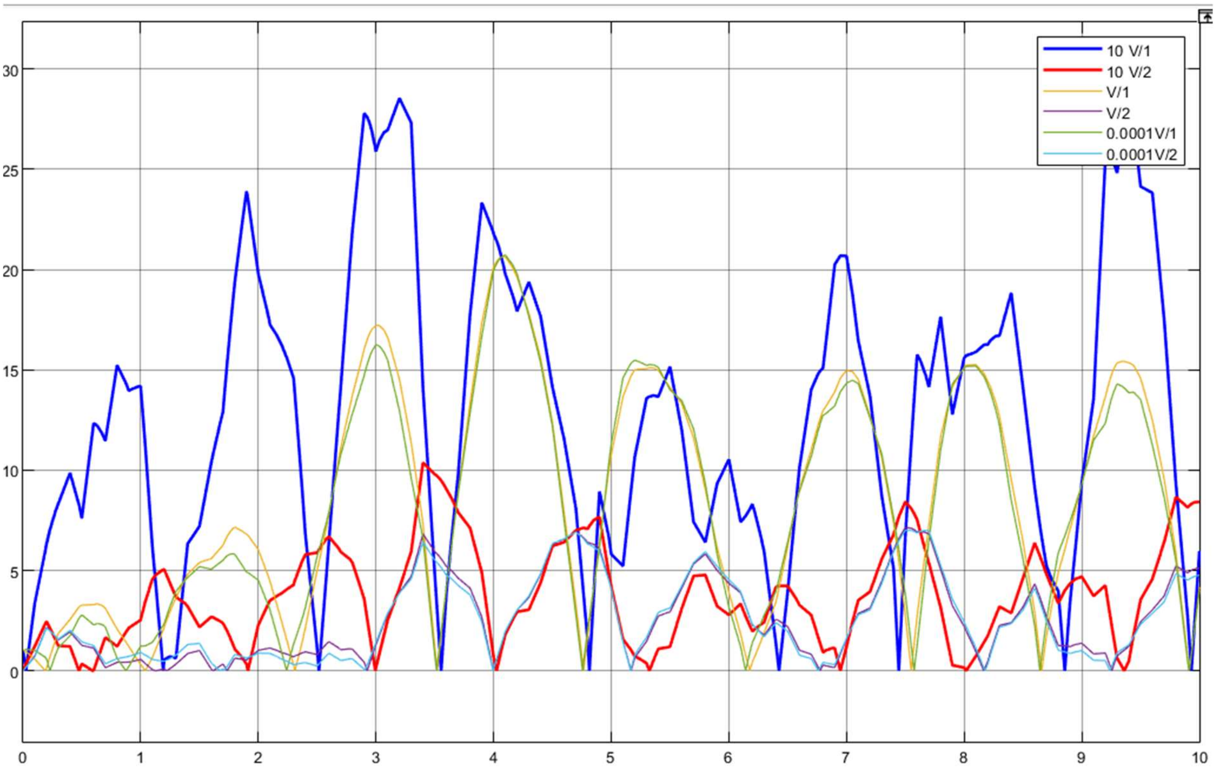
$$V = V^* \times 0.1$$
$$V = V^* \times 0.0001$$

Simulation Results

- variables e_{H1}, e_{H2}



- absolute value $|e_{H1}|, |e_{H2}|$



Conclusion: Generally speaking, within limits, the larger the spectral density V is, the bigger the observer errors are.