Practice4 Report

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摘要

This Practice work is mainly about how to transform a linear system between state-space form and diffrencial equation form. I used subsystem to show all models. The transfer function is used to check if I was right.Here is the overview of systems:

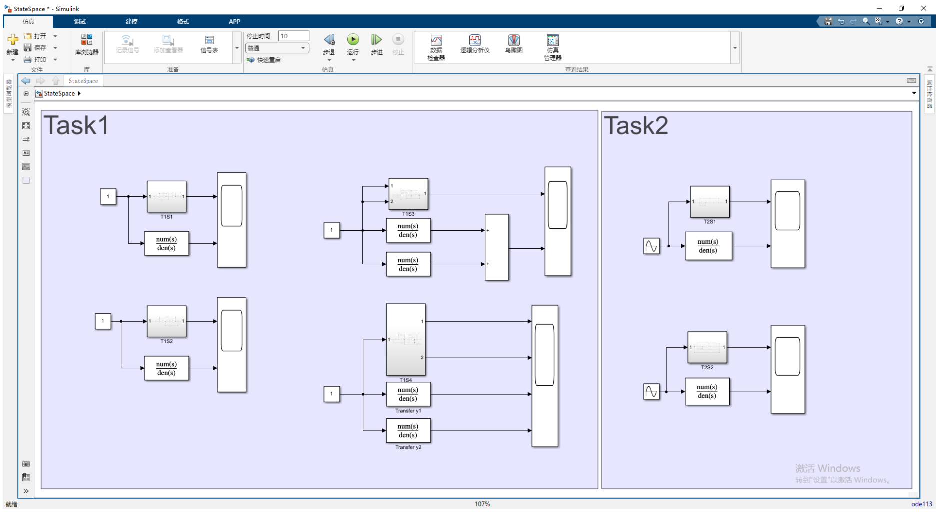


图 1: Overview of systems

1 Constructing Systems

Here shows the Detail of subsystem:

1.1 Task1

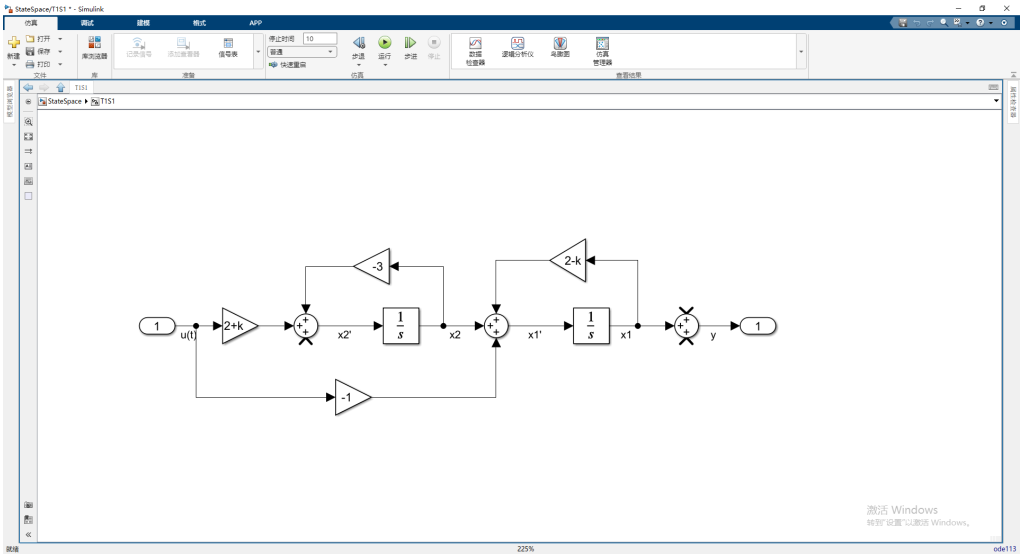


图 2: System1

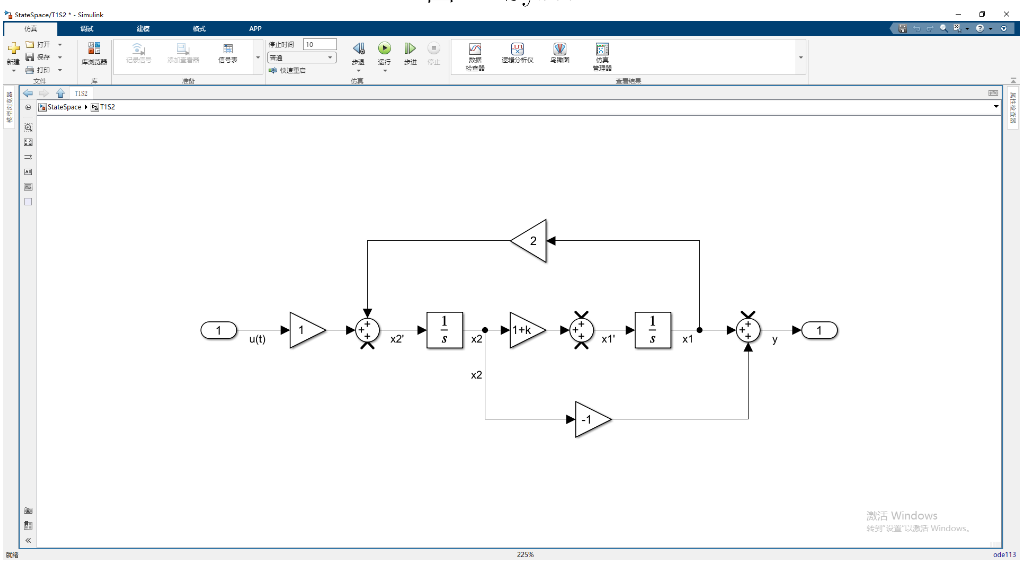


图 3: System2

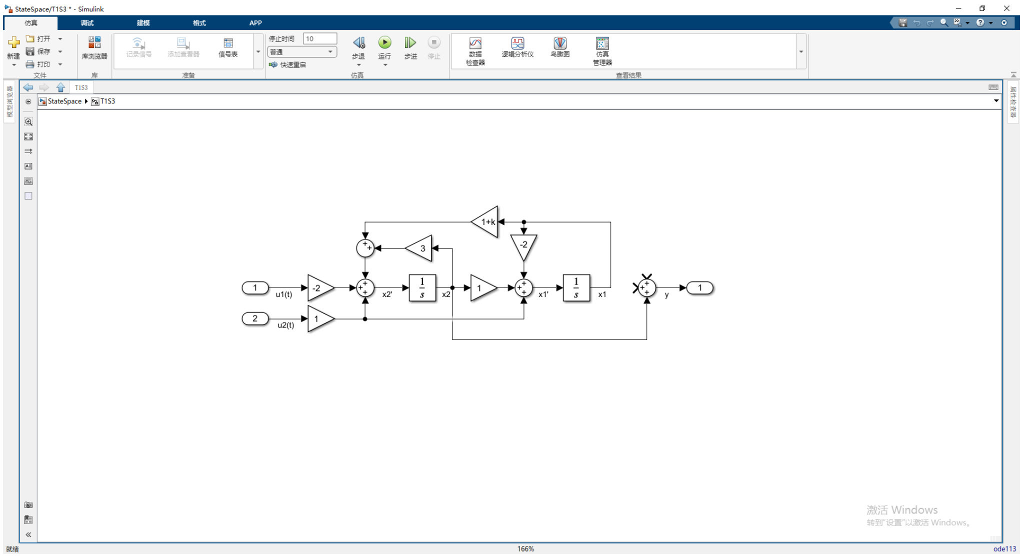


图 4: System3

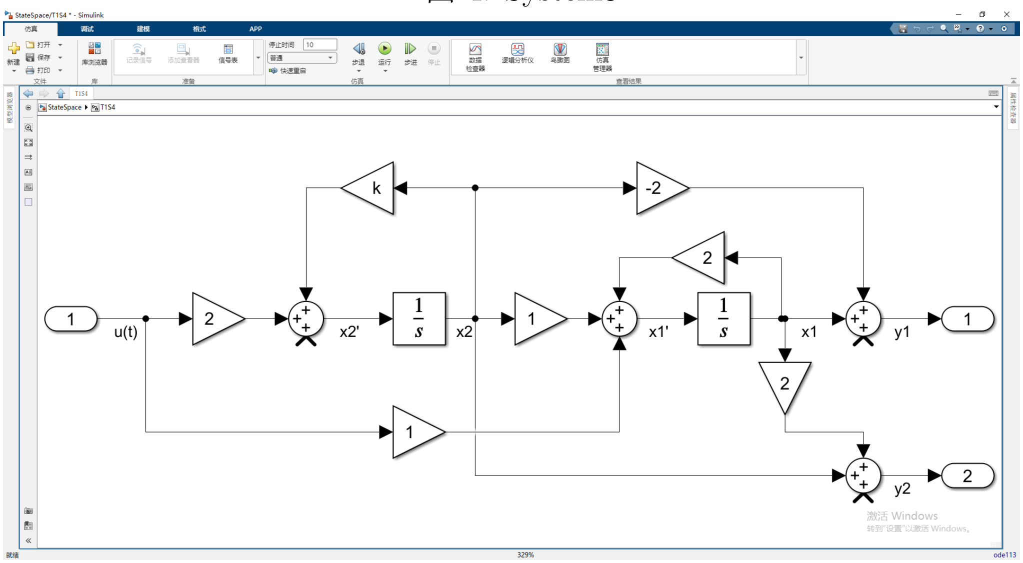


图 5: System4

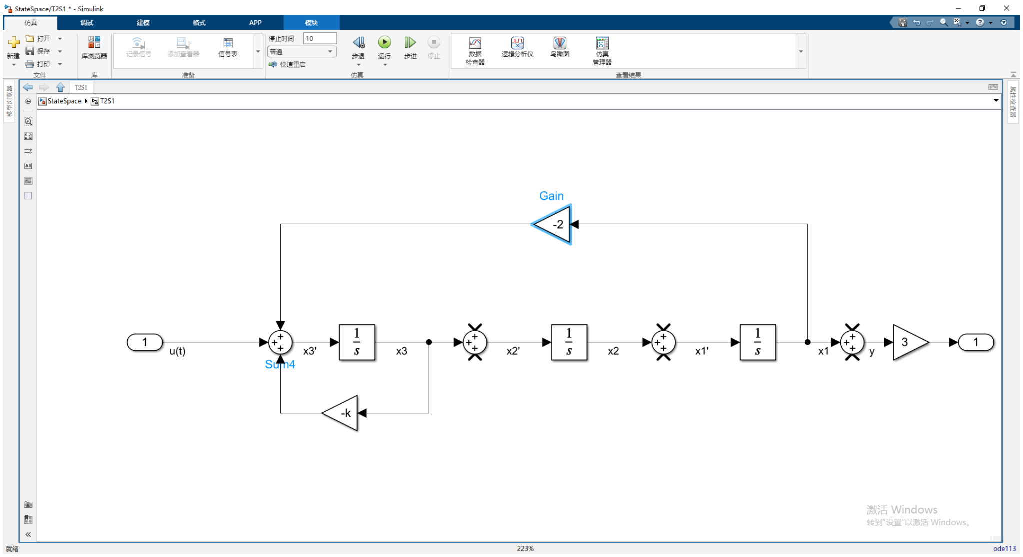


图 6: System1

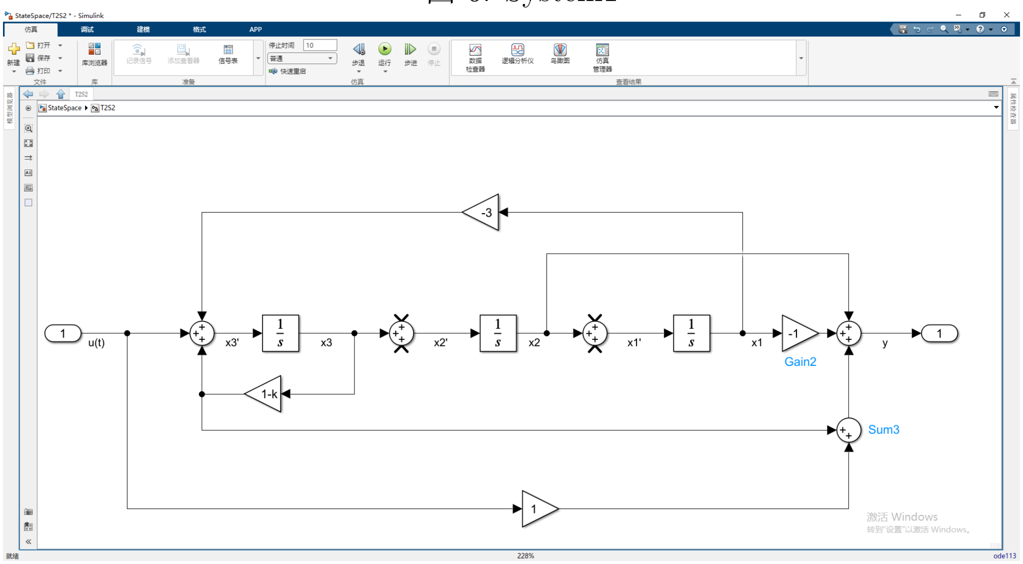


图 7: System2

1.2 Task2

2 Task1

2.1 Construct the system in MATLAB/Simulink

See above section.

2.2 Represent the system in the Input-Output form

Transfer function model Details:

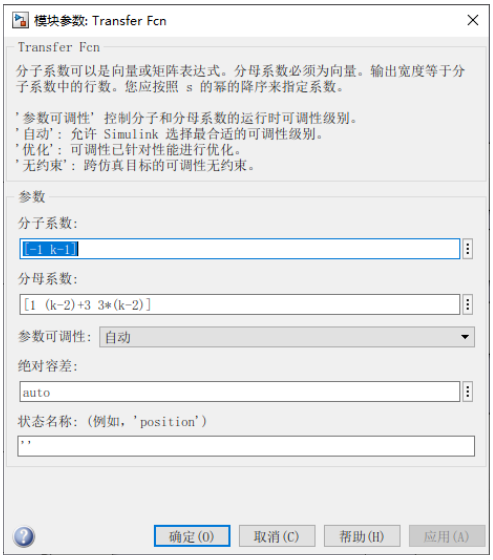


图 8: System1

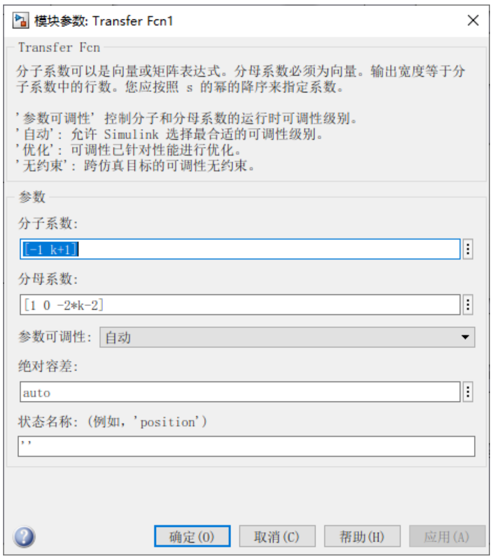


图 9: System2

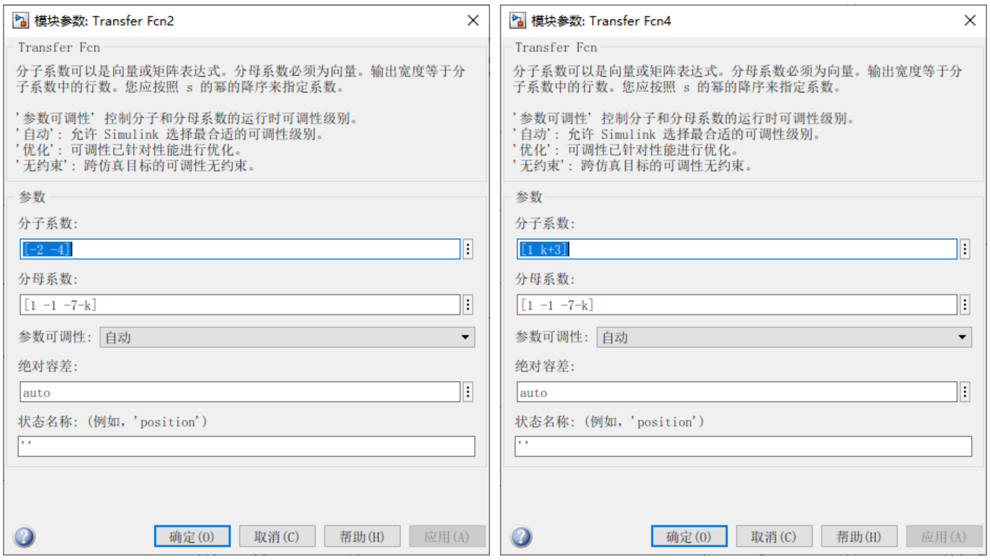


图 10: System3

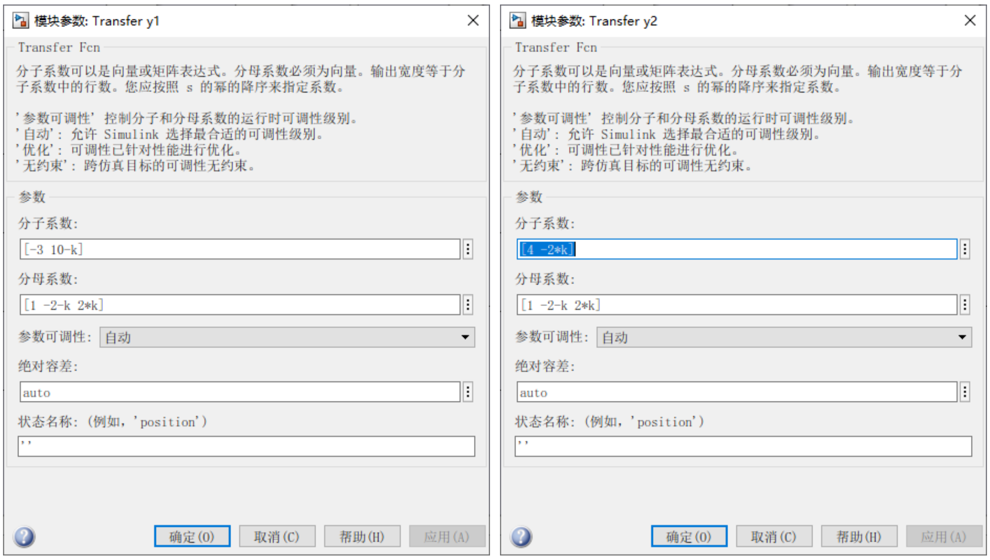
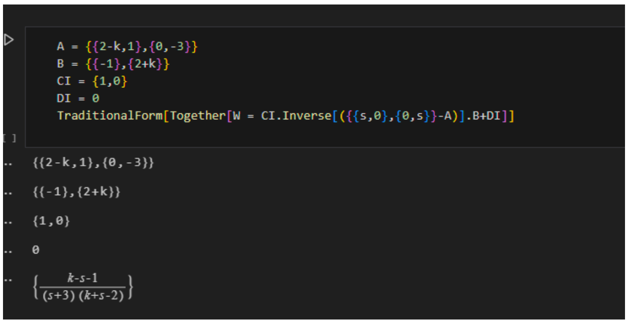


图 11: System4

Calculation by Wolfram Engine:

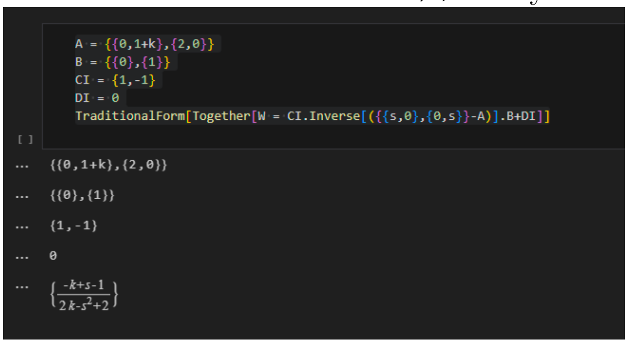


```
A = {{2-k,1},{0,-3}}
B = {{-1},{2+k}}
CI = {1,0}
DI = 0
TraditionalForm[Together[W = CI.Inverse[({{s,0},{0,s}}-A)].B+DI]]
```

```
{{2-k,1},{0,-3}}
{{-1},{2+k}}
{1,0}
0
```

$$\left\{\frac{k-s-1}{(s+3)(k+s-2)}\right\}$$

图 12: System1

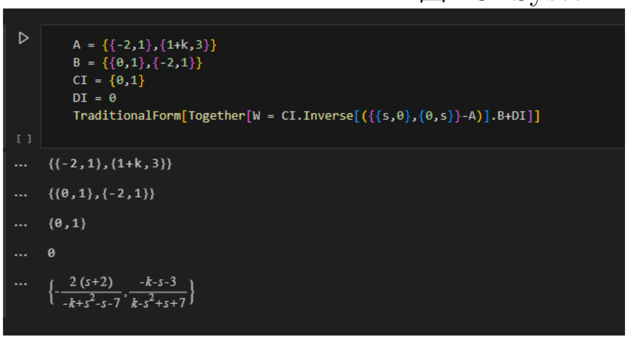


```
A = {{0,1+k},{2,0}}
B = {{0},{1}}
CI = {1,-1}
DI = 0
TraditionalForm[Together[W = CI.Inverse[({{s,0},{0,s}}-A)].B+DI]]
```

```
{{0,1+k},{2,0}}
{{0},{1}}
{1,-1}
0
```

$$\left\{\frac{-k+s-1}{2k-s^2+2}\right\}$$

图 13: System2

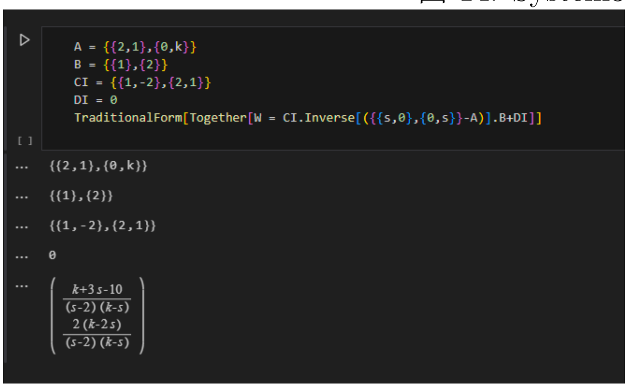


```
A = {{-2,1},{1+k,3}}
B = {{0,1},{-2,1}}
CI = {0,1}
DI = 0
TraditionalForm[Together[W = CI.Inverse[({{s,0},{0,s}}-A)].B+DI]]
```

```
{{-2,1},{1+k,3}}
{{0,1},{-2,1}}
{0,1}
0
```

$$\left\{-\frac{2(s+2)}{-k+s^2-s-7},\frac{-k-s-3}{k-s^2+s+7}\right\}$$

图 14: System3



```
A = {{2,1},{0,k}}
B = {{1},{2}}
CI = {{1,-2},{2,1}}
DI = 0
TraditionalForm[Together[W = CI.Inverse[({{s,0},{0,s}}-A)].B+DI]]
```

```
{{2,1},{0,k}}
{{1},{2}}
{{1,-2},{2,1}}
0
```

$$\begin{pmatrix}\frac{k+3s-10}{(s-2)(k-s)}\\ \frac{2(k-2s)}{(s-2)(k-s)}\end{pmatrix}$$

图 15: System4

2.3 Stablity

$$k = 7$$

For System1:

$$det(A - \lambda * I) = \begin{vmatrix} 2-k-\lambda & 1 \\ 0 & -3-\lambda \end{vmatrix} = 0$$

$$- > \lambda_1 = -3, \lambda_2 = 2 - k$$

Getting $\lambda_1 = -3, \lambda_2 = -5$ For me. So System1 is asymptotically stable in my case, performing **Node Behavior**.

For System2:

$$det(A - \lambda * I) = \begin{vmatrix} 0-\lambda & 1+k \\ 2 & 0-\lambda \end{vmatrix} = 0$$

Getting $\lambda_1 = 4, \lambda_2 = -4$ For me. So System2 is not stable in my case, performing **Saddle Behavior**.

For System3:

$$det(A - \lambda * I) = \begin{vmatrix} -2-\lambda & 1 \\ 1+k & 3-\lambda \end{vmatrix} = 0$$

Getting $\lambda_1 = \frac{1-\sqrt{57}}{2}, \lambda_2 = \frac{1+\sqrt{57}}{2}$ For me. So System3 is not stable in my case, performing **Saddle Behavior**.

For System4:

$$det(A - \lambda * I) = \begin{vmatrix} 2-\lambda & 1 \\ 0 & k-\lambda \end{vmatrix} = 0$$

Getting $\lambda_1 = 2, \lambda_2 = 7$ For me. So System4 is not stable in my case, performing **Node Behavior**.

3 Task2

3.1 Represent the system in the canonical State-Space forms

System1:

Controlable

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & 0 & -k \end{bmatrix}$$

$$B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

$$C = \begin{bmatrix} 3 & 0 & 0 \end{bmatrix}$$

Observable

$$A = \begin{bmatrix} -k & 1 & 0 \\ 0 & 0 & 1 \\ -2 & 0 & 0 \end{bmatrix}$$

$$B = \begin{bmatrix} 0 \\ 0 \\ 3 \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$$

System2:

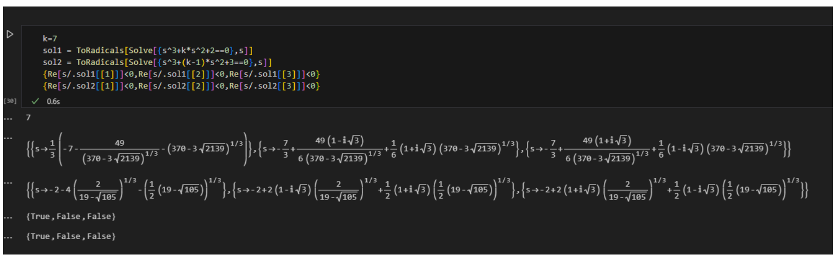
Controlable

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & 0 & k+1 \end{bmatrix}$$
$$B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$
$$C = \begin{bmatrix} 2-3 & 1-0 & -k+1 \end{bmatrix}$$
$$D = b_n = 1(\text{not } b_0)$$

Observable

$$A = \begin{bmatrix} -3 & 1 & 0 \\ 0 & 0 & 1 \\ k+1 & 0 & 0 \end{bmatrix}$$
$$B = \begin{bmatrix} -k+1 \\ 1-0 \\ 2-3 \end{bmatrix}$$
$$C = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$$
$$D = b_n = 1(\text{not } b_0)$$

3.2 Is system stable for u(t) = 0 ?



(Very Complex solve?) Not for all $Re(s) < 0$,Leading not stable.

3.3 Construct the system in MATLAB/Simulink

See section **Constructing Systems**.

4 Figures

4.1 Task1

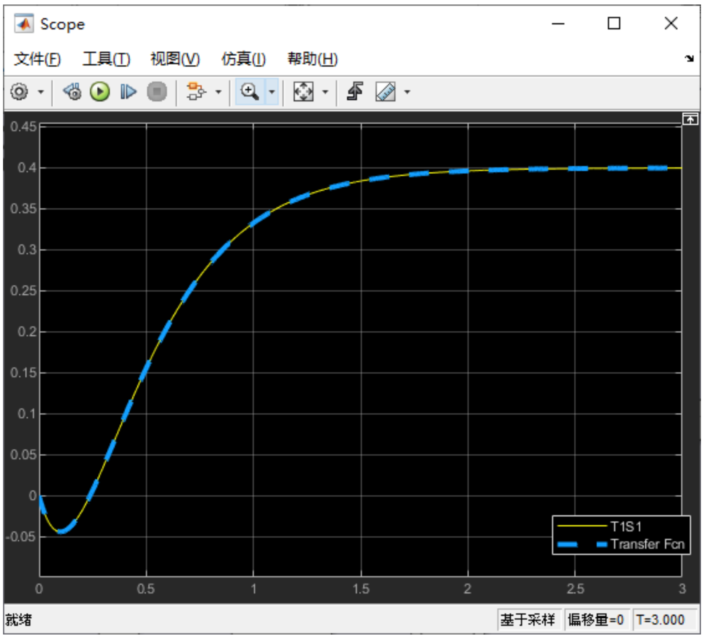


图 16: System1

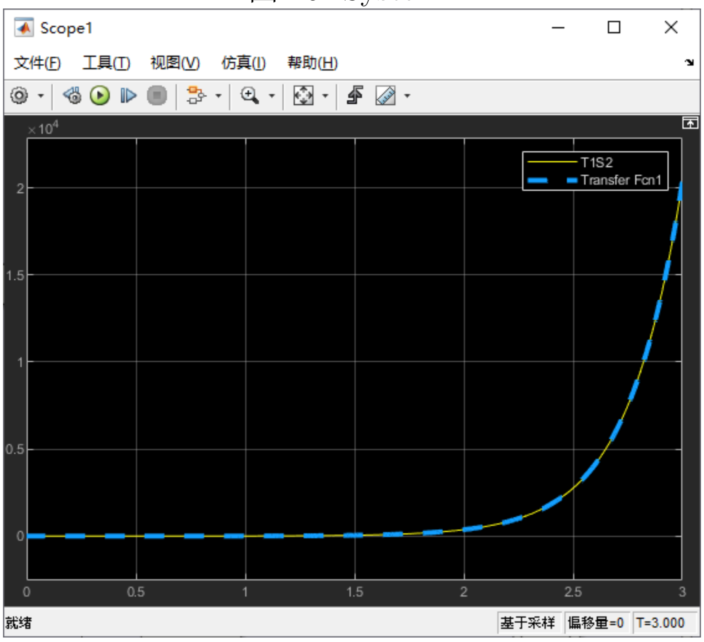


图 17: System2

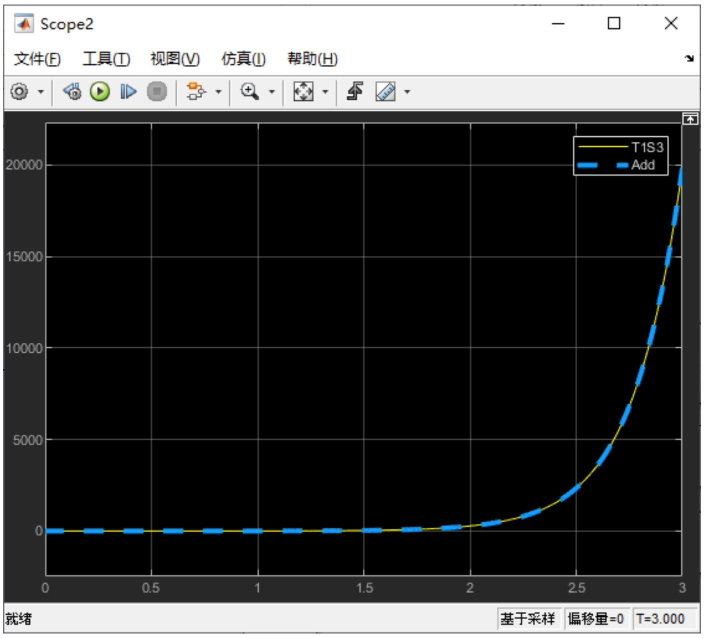


图 18: System3

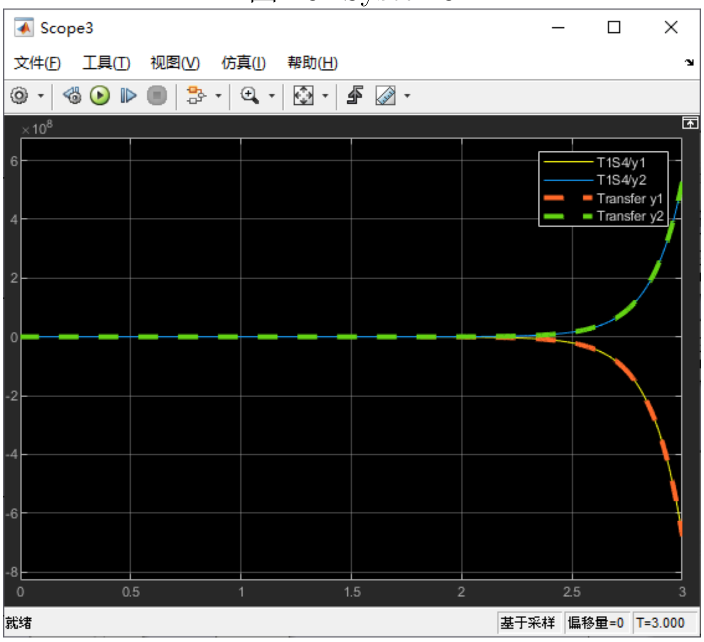


图 19: System4

4.2 Task2

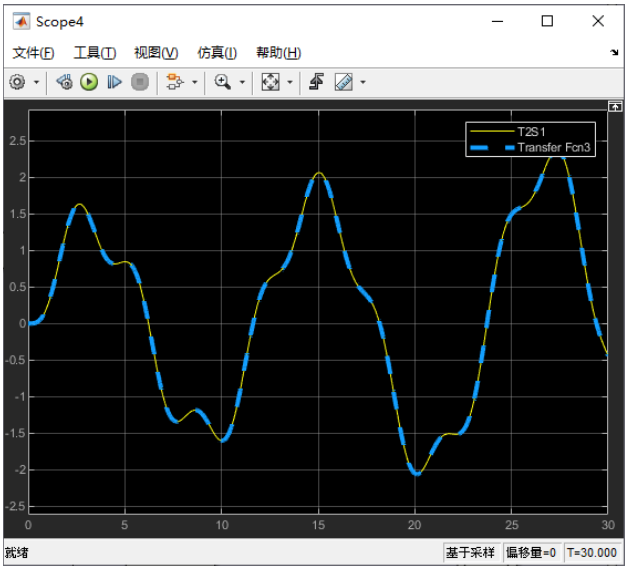


图 20: System1

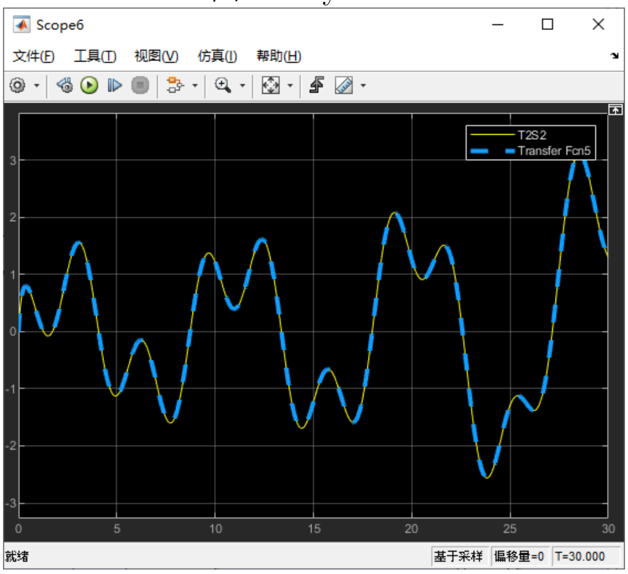


图 21: System2