

自动控制理论 B

Matlab 仿真实验报告

实 验 名 称 : 相平面分析

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一、 线性系统的相平面图

此部分内容需要自己设置参数、搭建仿真图、时间响应曲线、相平面图。对于奇点为节点和鞍点的情形，要画出特殊等倾线对应的相轨迹。

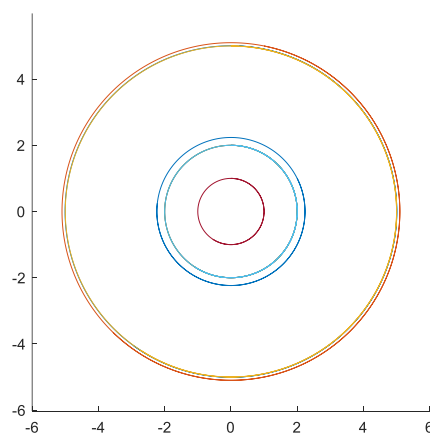
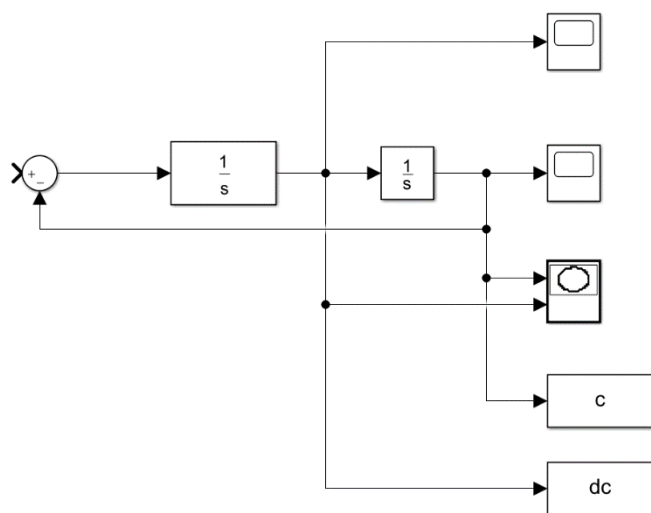
1. 中心点

取开环传递函数为 $G(s) = \frac{1}{s^2}$,

闭环特征方程为 $s^2 + 1 = 0$

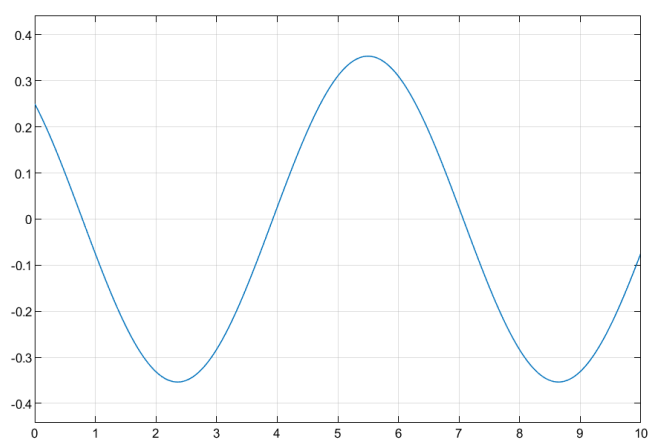
解得特征根为 $s_1 = i, s_2 = -i$,

无特殊等倾线

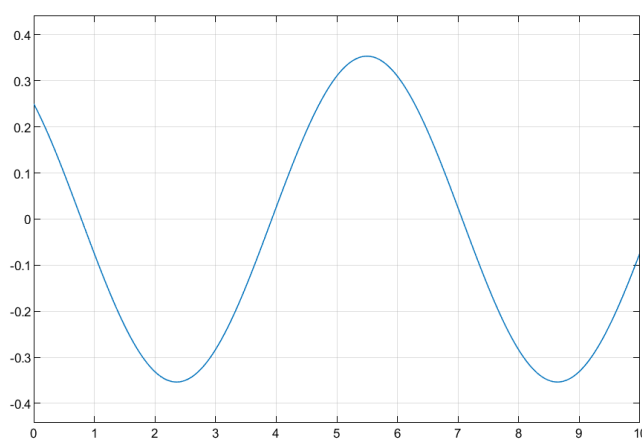


仿真图

相平面图



时间响应曲线 (c, $c(0)=0.25$)



时间响应曲线 (dc, $dc(0)=0.25$)

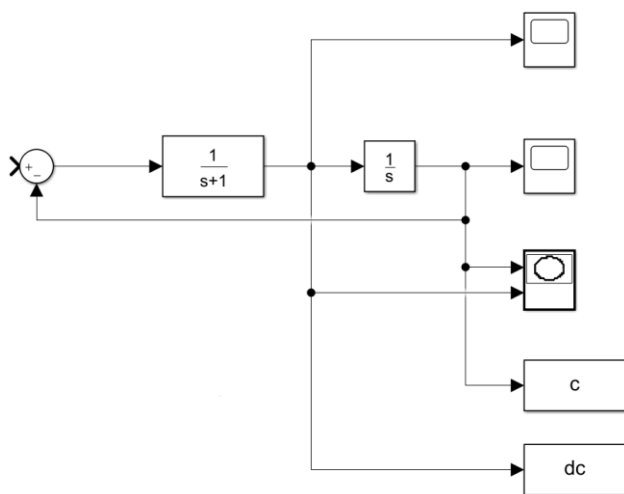
2. 稳定焦点

取开环传递函数为 $G(s) = \frac{1}{s^2+s}$,

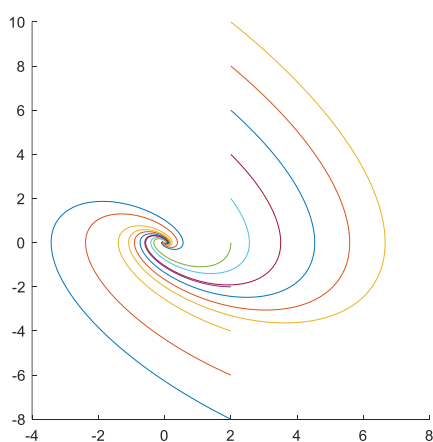
系统闭环特征方程为 $s^2 + s + 1 = 0$

特征根为 $s_1 = -\frac{1}{2} + \frac{\sqrt{3}}{2}i, s_2 = -\frac{1}{2} - \frac{\sqrt{3}}{2}i$,

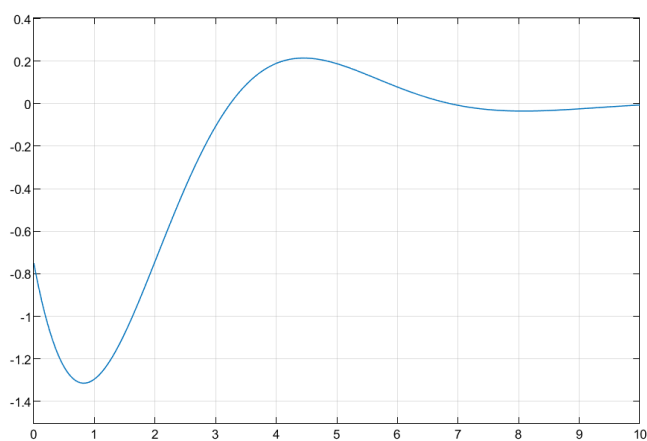
无特殊等倾线。



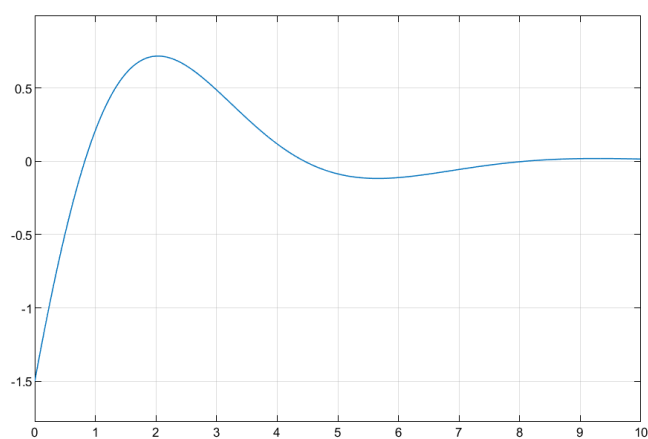
仿真图



相平面图



时间响应曲线 (c, $c(0)=-0.75$)



时间响应曲线 (dc, $dc(0)=-1.5$)

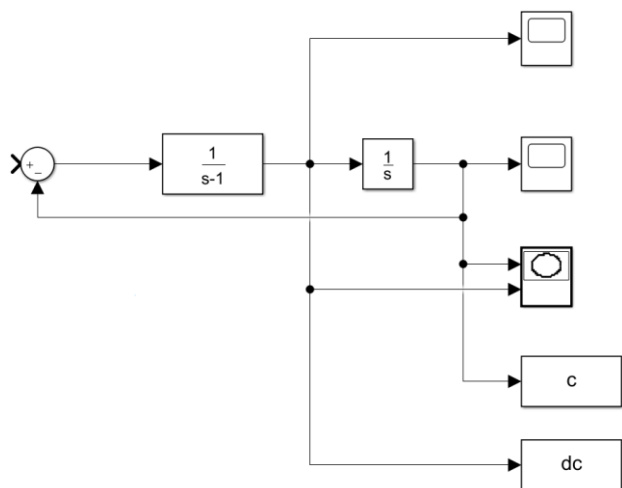
3. 不稳定焦点

取开环传递函数为 $G(s) = \frac{1}{s^2 - s}$,

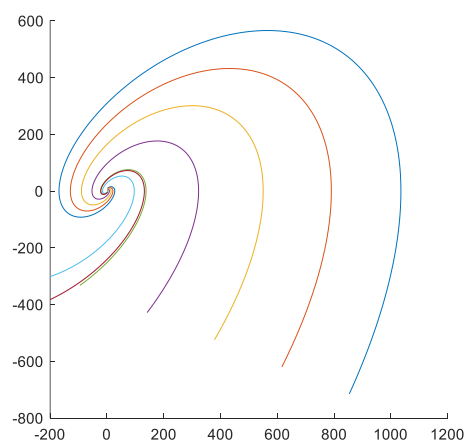
系统闭环特征方程为 $s^2 - s + 1 = 0$

特征根为 $s_1 = \frac{1}{2} + \frac{\sqrt{3}}{2}i, s_2 = \frac{1}{2} - \frac{\sqrt{3}}{2}i$,

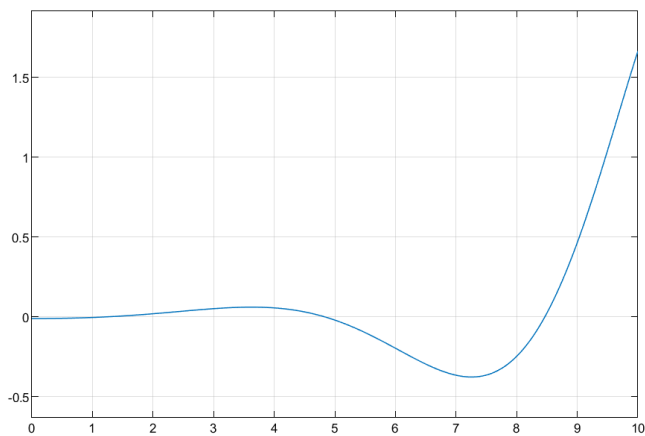
无特殊等倾线。



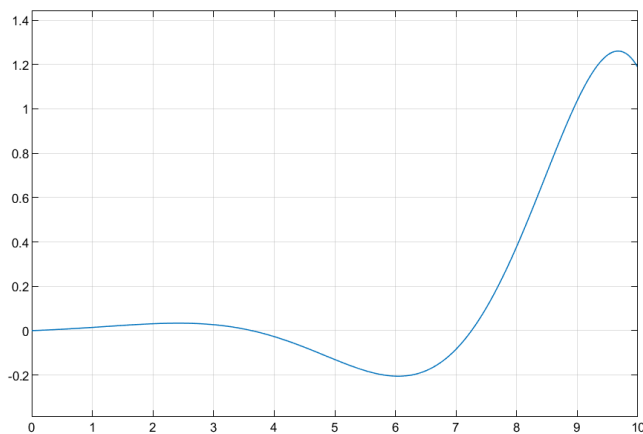
仿真图



相平面图



时间响应曲线 ($c, c(0)=-0.01$)



时间响应曲线 ($dc, dc(0)=0$)

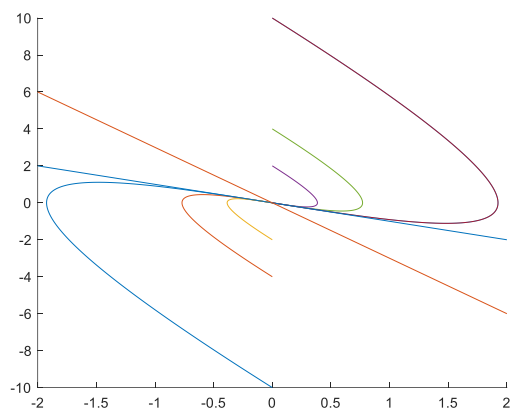
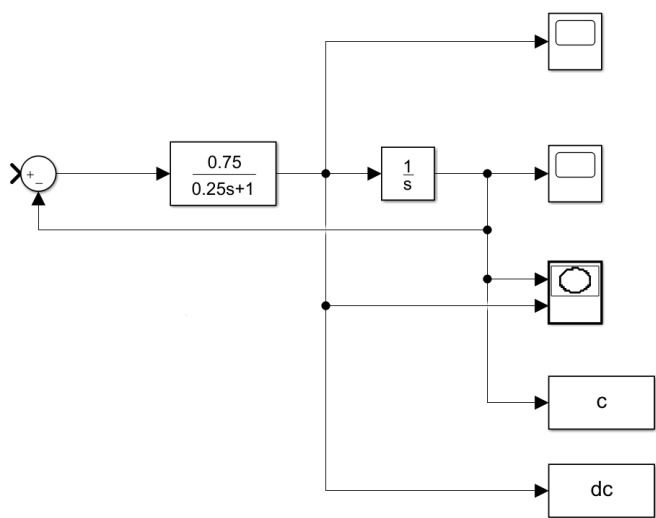
4. 稳定节点

取开环传递函数为 $G(s) = \frac{3}{s^2+4s}$

系统闭环特征方程为 $s^2 + 4s + 3 = 0$

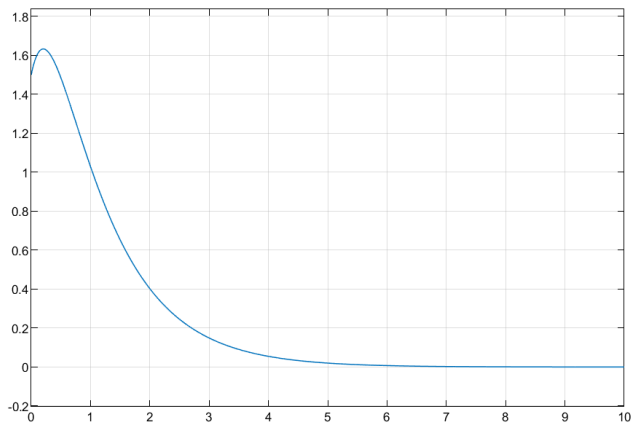
特征根为 $s_1 = -1, s_2 = -3$

特殊等倾线为 $\dot{c} = -c, \dot{c} = -3c$

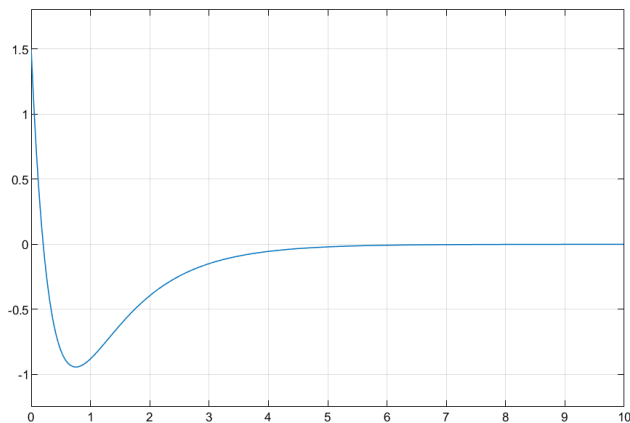


搭建仿真图

相平面图



时间响应曲线 ($c, c(0)=1.5$)



时间响应曲线 ($dc, dc(0)=1.5$)

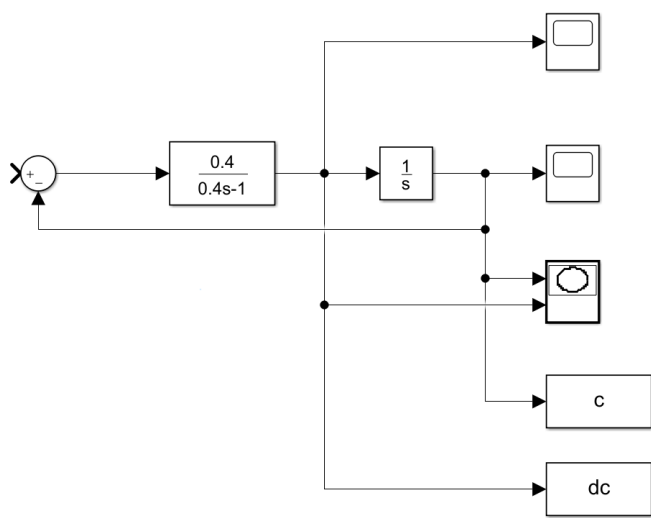
5. 不稳定节点

取开环传递函数为 $G(s) = \frac{0.4}{0.4s^2 - s}$

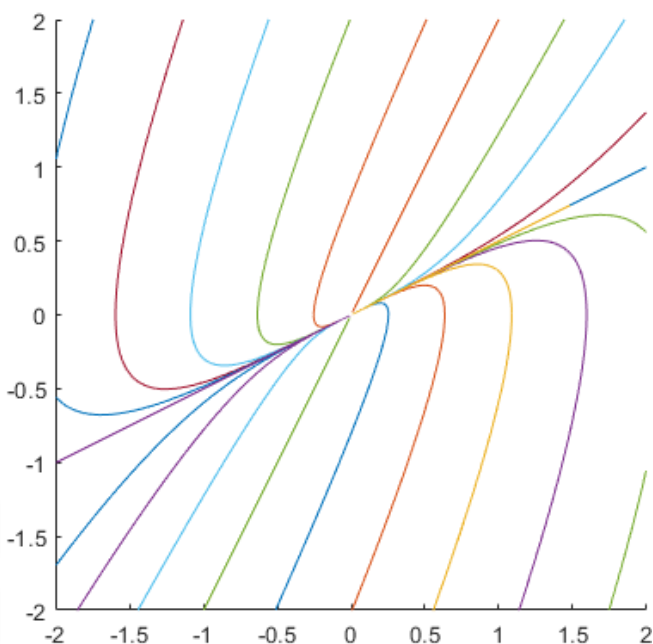
系统闭环特征方程为 $s^2 - 2.5s + 1 = 0$

特征根为 $s_1 = -0.5, s_2 = -2$

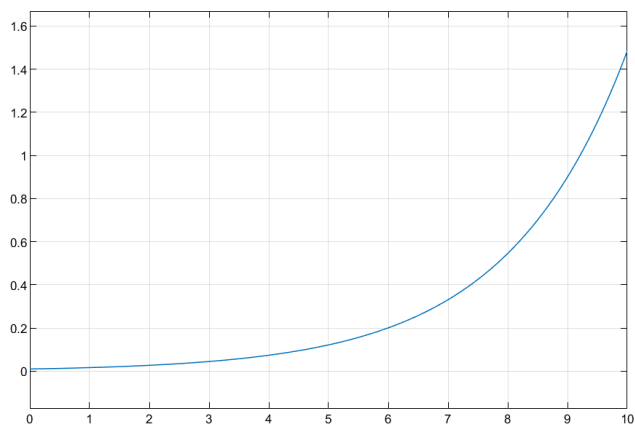
特殊等倾线为 $\dot{c} = -0.5c, \dot{c} = -2c$



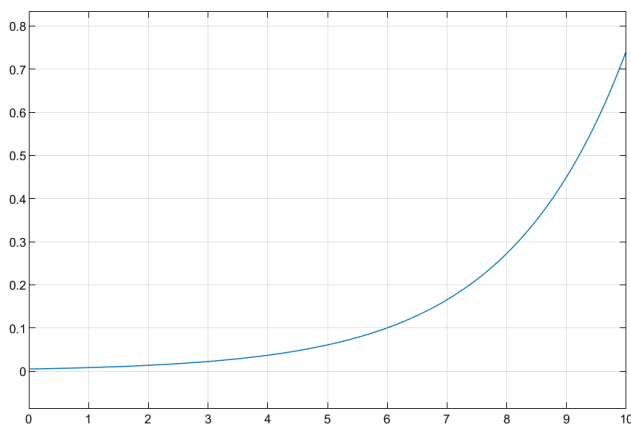
搭建仿真图



相平面图



时间响应曲线 ($c, c(0)=0.01$)



时间响应曲线 ($dc, dc(0)=0.005$)

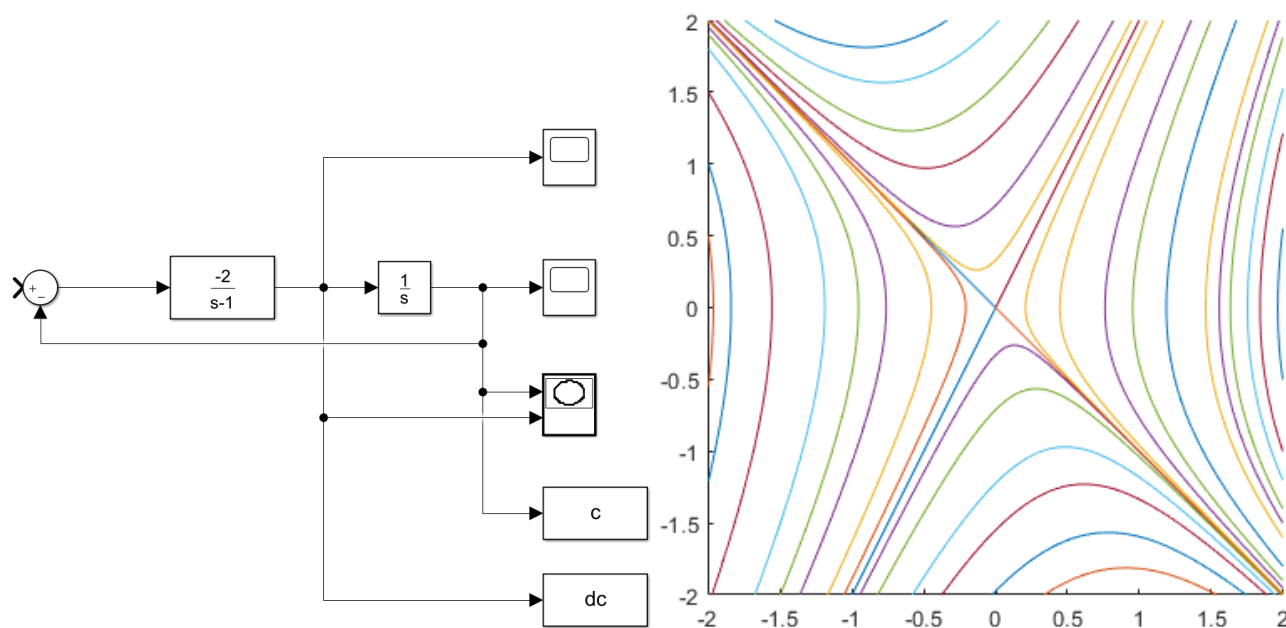
6. 鞍点

取开环传递函数为 $G(s) = \frac{-2}{s^2 - s}$

系统闭环特征方程为 $s^2 - s - 2 = 0$

特征根为 $s_1 = -1, s_2 = 2$

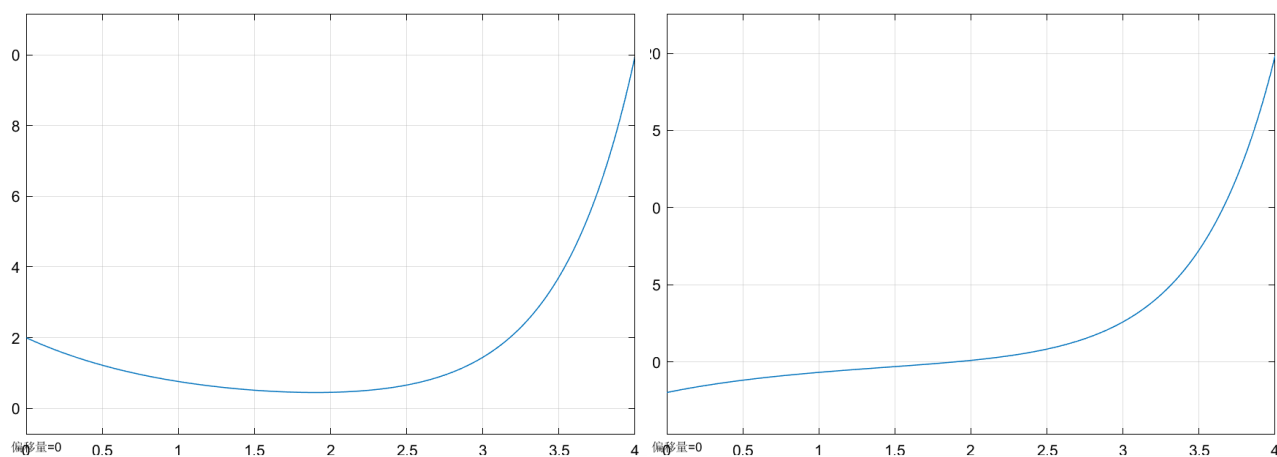
特殊等倾线为 $\dot{c} = -c, \dot{c} = 2c$



搭建仿真图

相平面图

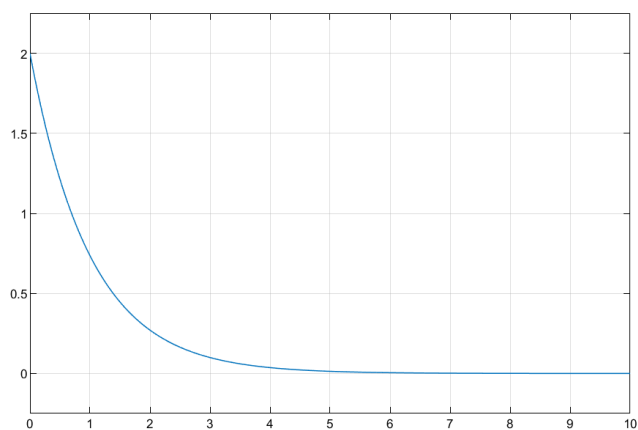
初始点不在特殊等倾线上的时间响应曲线



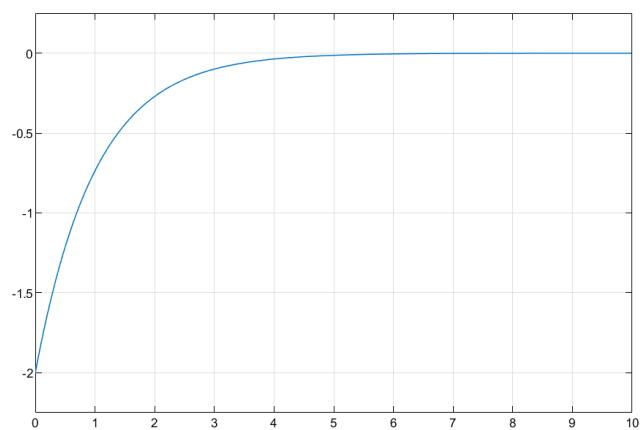
时间响应曲线 ($c, c(0)=2$)

时间响应曲线 ($dc, dc(0)=-1.99$)

初始点在特殊等倾线 $\dot{c} = -c$ 上的时间响应曲线

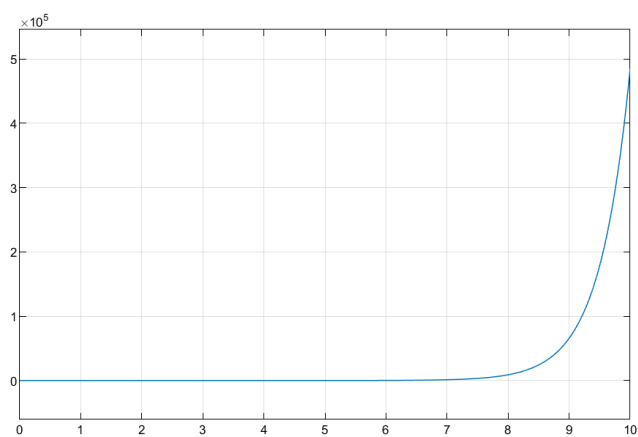


时间响应曲线 ($c, c(0)=2$)

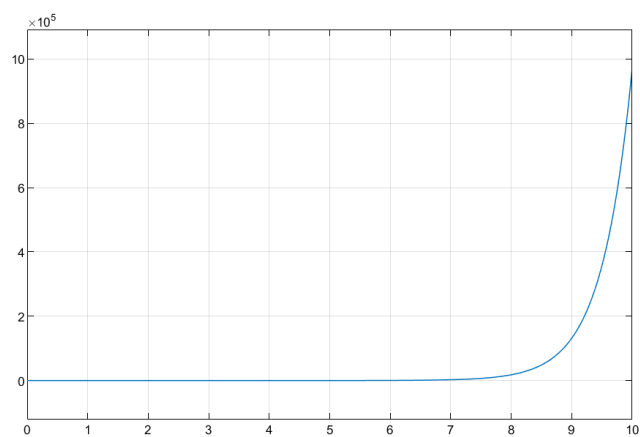


时间响应曲线 ($dc, dc(0)=-2$)

初始点在特殊等倾线 $\dot{c} = 2c$ 上的时间响应曲线



时间响应曲线 ($c, c(0)=0.001$)

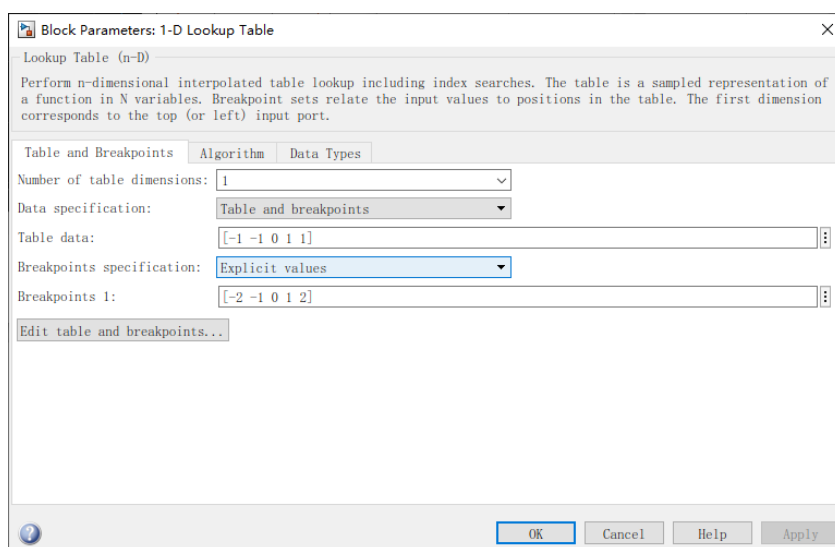
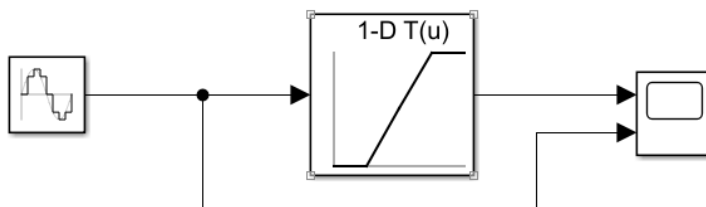


时间响应曲线 ($dc, dc(0)=-0.002$)

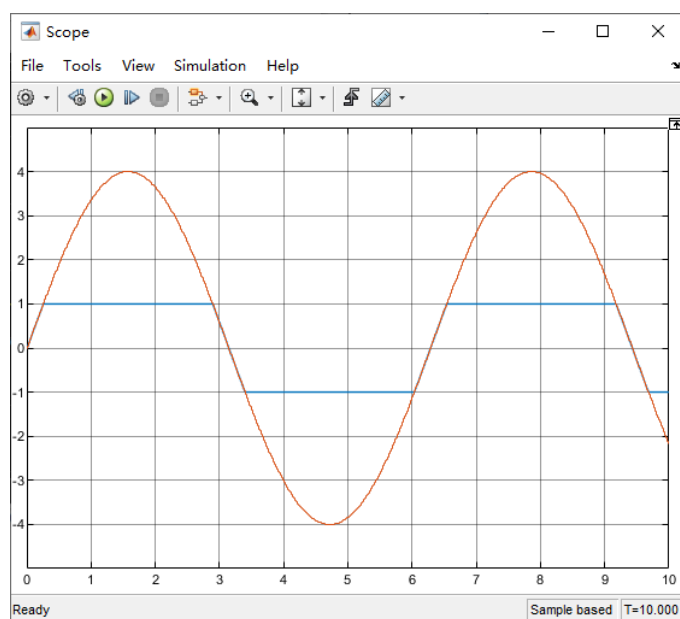
二、非线性环节的 Lookup tables 表示方法

此部分内容需要截图 Lookup table 的参数设置界面、画出输入为正弦信号时的输出响应（在同一个图里画出输入输出曲线）。

1. 饱和特性

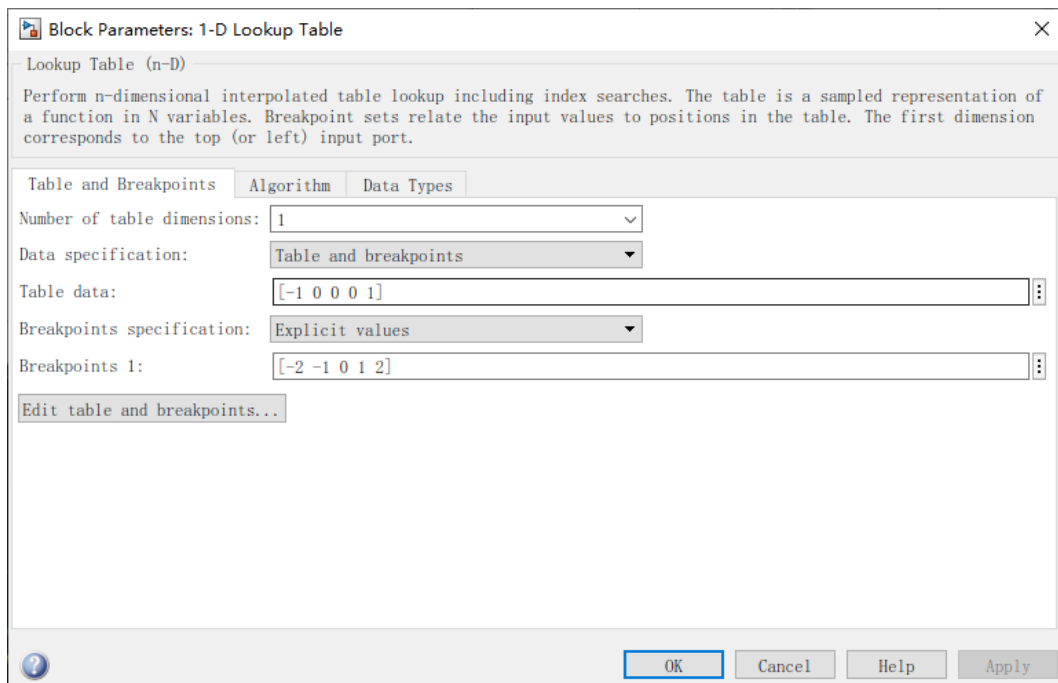


参数设置界面

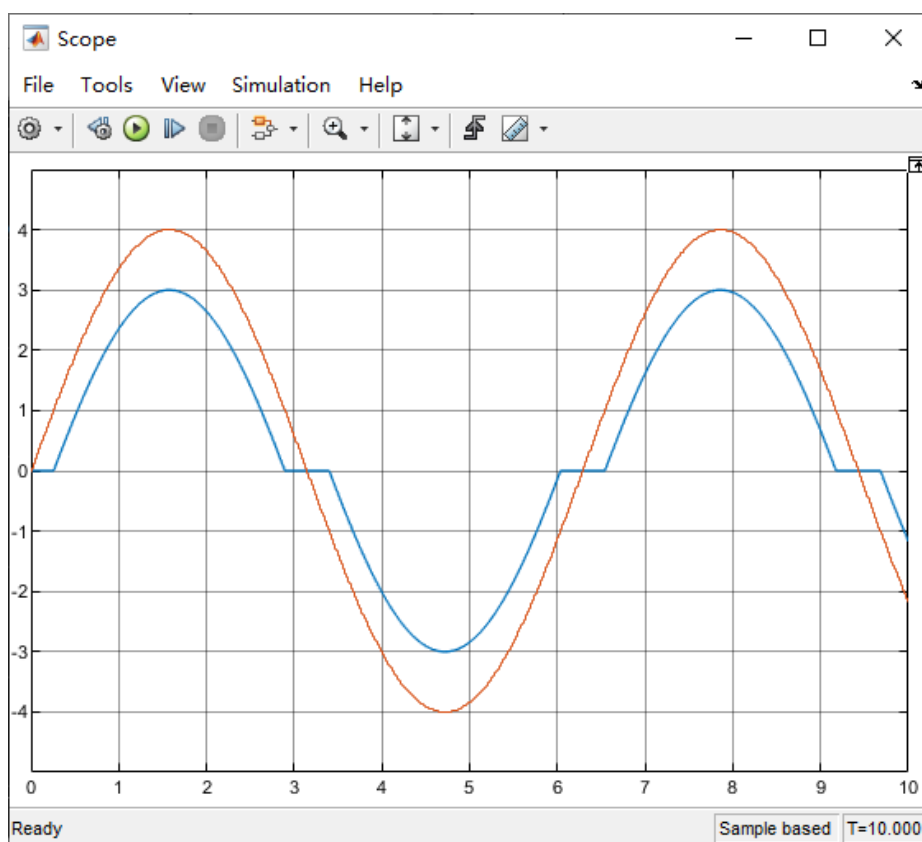


输入输出曲线

2. 死区特性

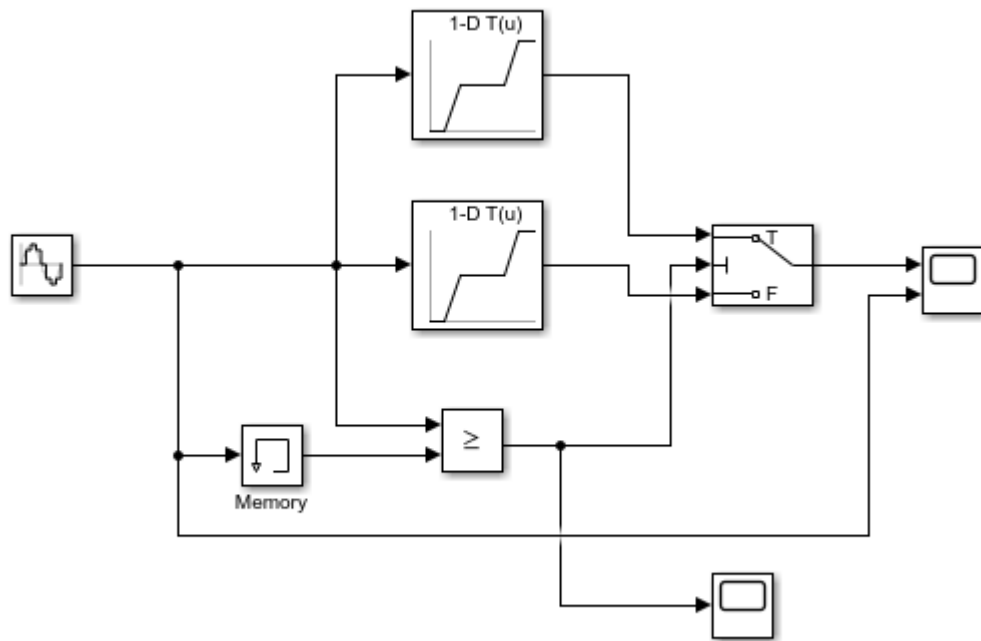


参数设置界面

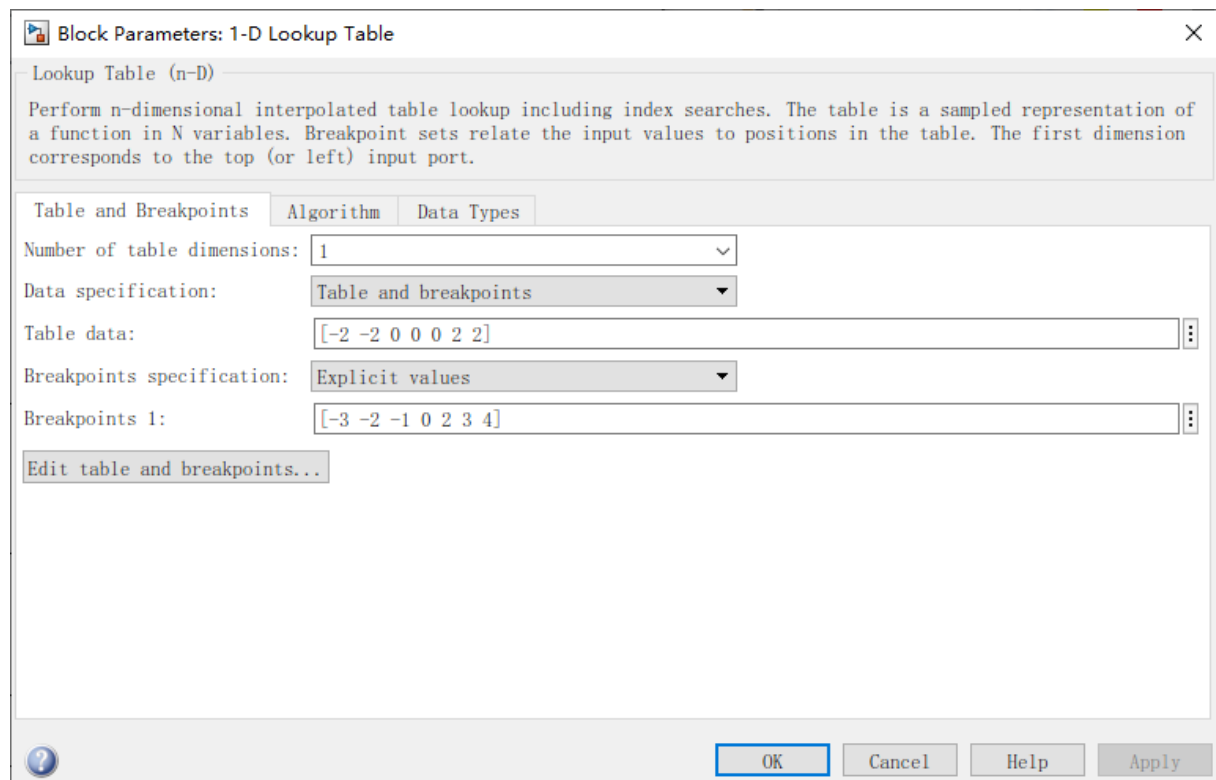


输入输出曲线

3. 滞环特性



仿真模型



参数设置 1

Block Parameters: 1-D Lookup Table1 ✕

Lookup Table (n-D)

Perform n-dimensional interpolated table lookup including index searches. The table is a sampled representation of a function in N variables. Breakpoint sets relate the input values to positions in the table. The first dimension corresponds to the top (or left) input port.

Table and Breakpoints Algorithm Data Types

Number of table dimensions: 1

Data specification: Table and breakpoints

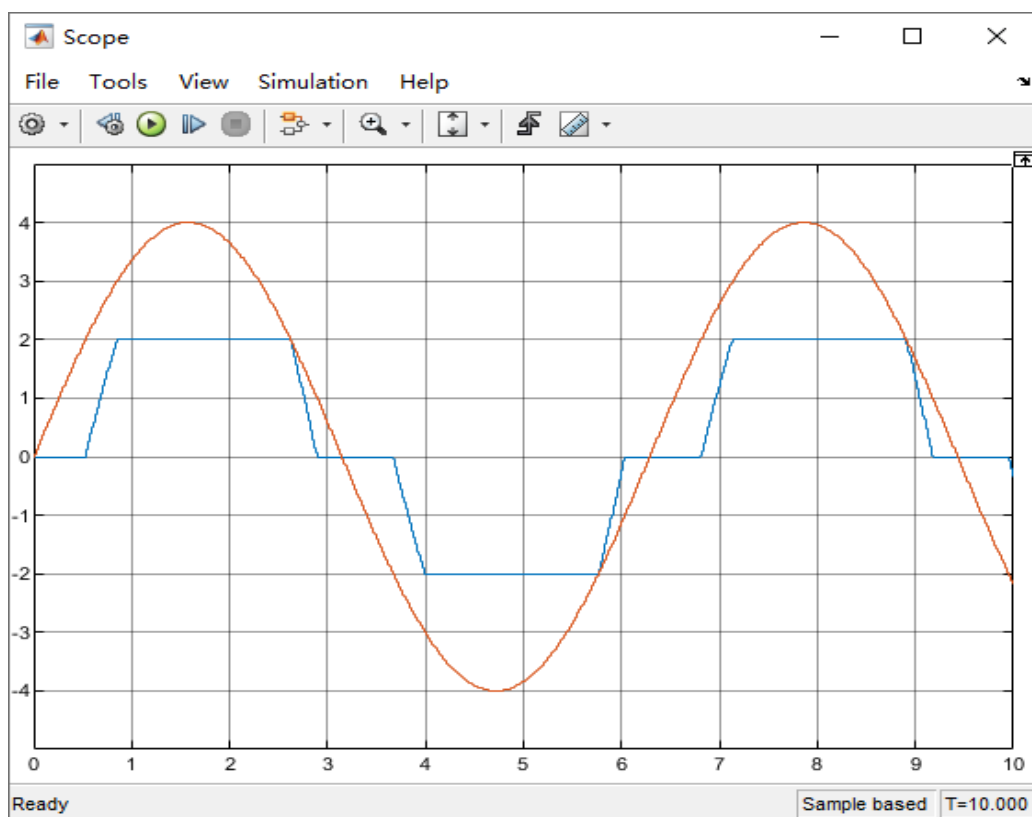
Table data: [-2 -2 0 0 0 2 2]

Breakpoints specification: Explicit values

Breakpoints 1: [-4 -3 -2 0 1 2 3]

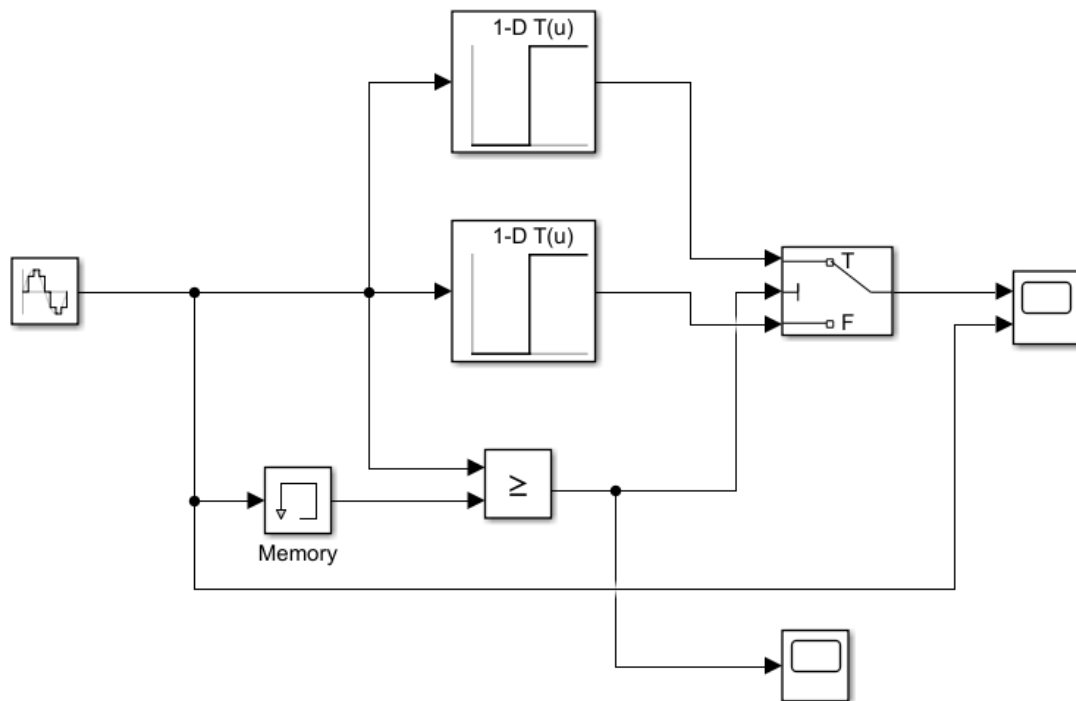
Edit table and breakpoints...

参数设置 2

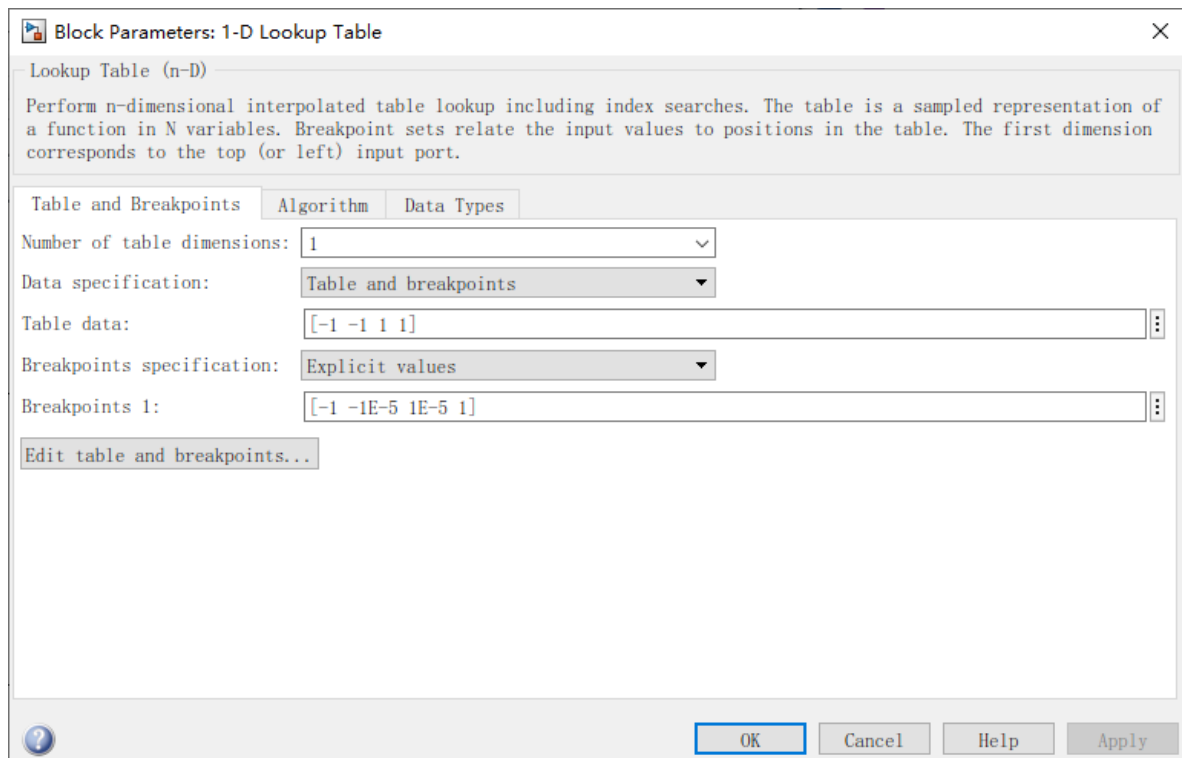


输入输出曲线

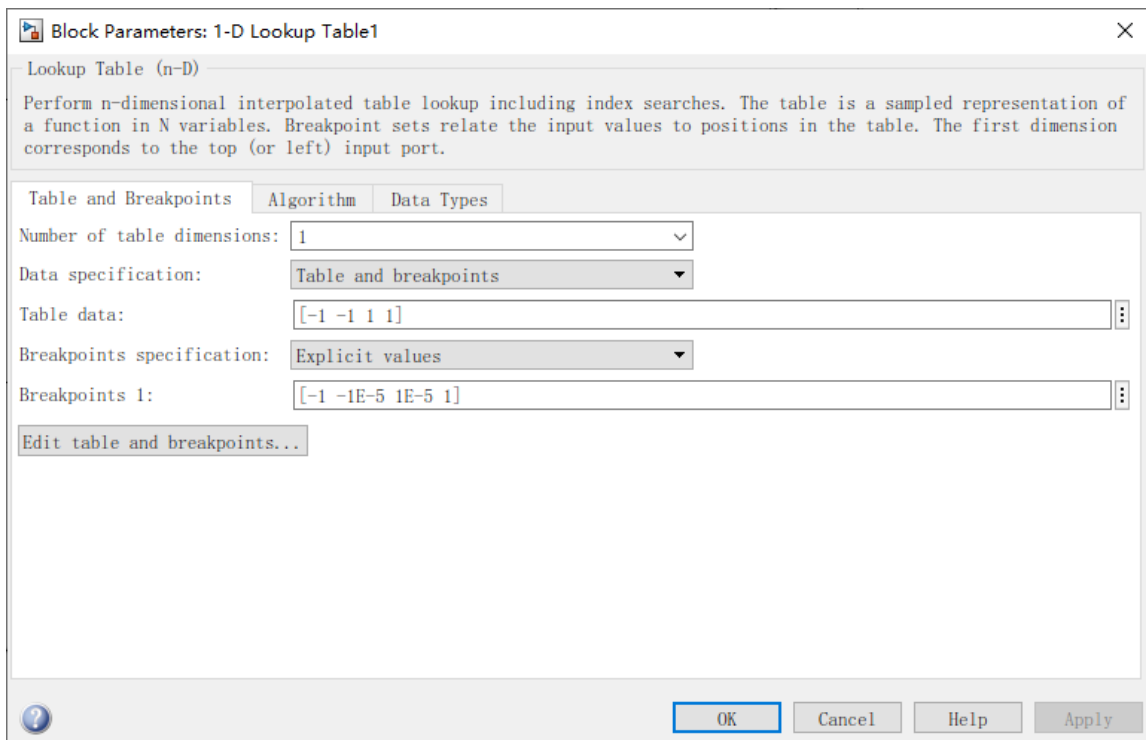
4. 理想继电特性



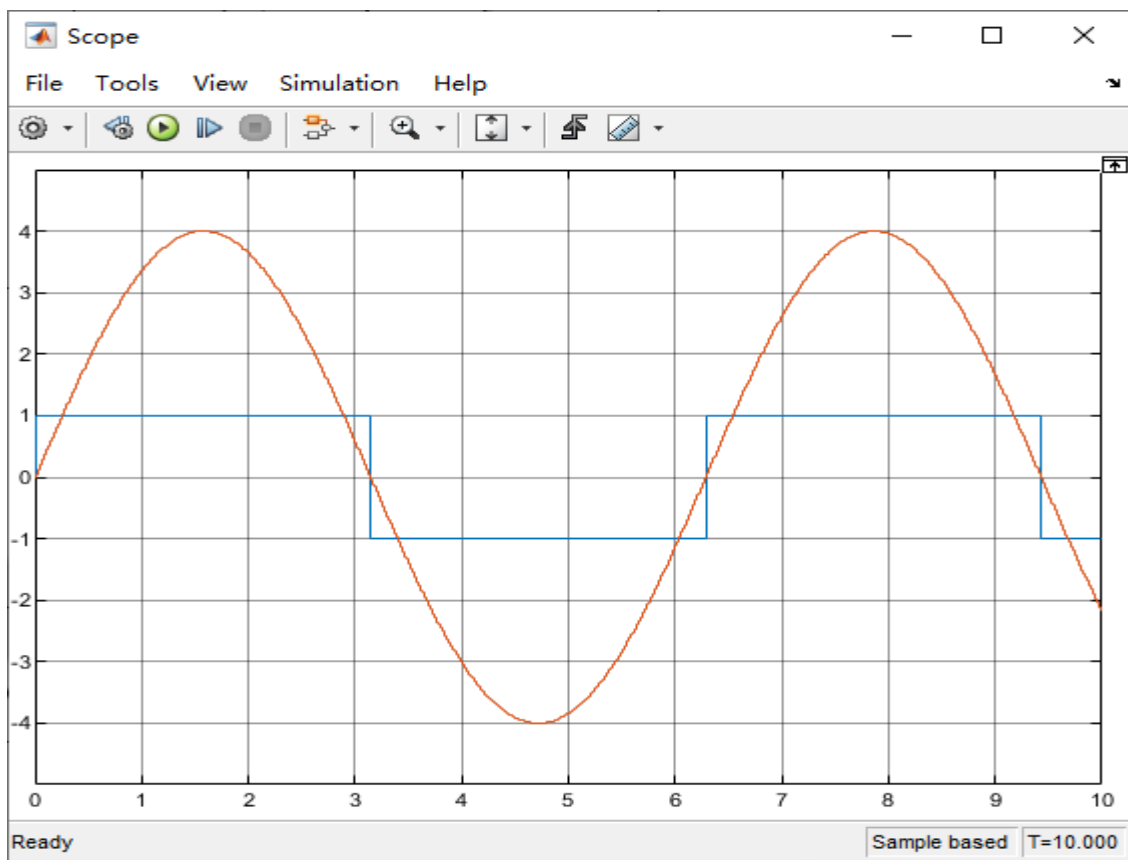
仿真模型



参数设置 1




参数设置 2



输入输出波形

5. 死区继电特性

 **Block Parameters: 1-D Lookup Table** ✕

Lookup Table (n-D)

Perform n-dimensional interpolated table lookup including index searches. The table is a sampled representation of a function in N variables. Breakpoint sets relate the input values to positions in the table. The first dimension corresponds to the top (or left) input port.

Table and Breakpoints Algorithm Data Types

Number of table dimensions: 1


Data specification: Table and breakpoints

Table data: [-1 -1 0 0 1 1]


Breakpoints specification: Explicit values

Breakpoints 1: [-2 -1.001 -1 1 1.001 2]

Edit table and breakpoints...

 OK Cancel Help Apply

参数设置 1

 **Block Parameters: 1-D Lookup Table1** ✕

Lookup Table (n-D)

Perform n-dimensional interpolated table lookup including index searches. The table is a sampled representation of a function in N variables. Breakpoint sets relate the input values to positions in the table. The first dimension corresponds to the top (or left) input port.

Table and Breakpoints Algorithm Data Types

Number of table dimensions: 1


Data specification: Table and breakpoints

Table data: [-1 -1 0 0 1 1]

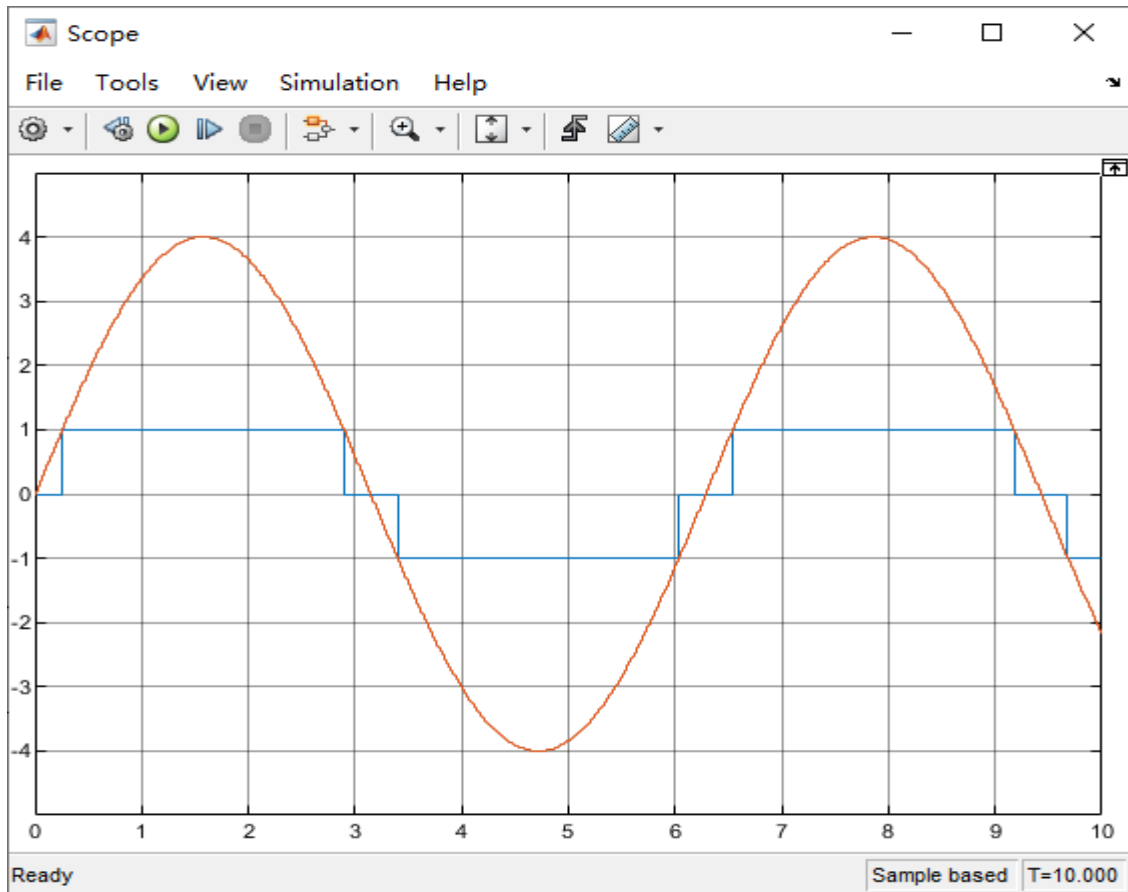
Breakpoints specification: Explicit values

Breakpoints 1: [-2 -1.001 -1 1 1.001 2]

Edit table and breakpoints...

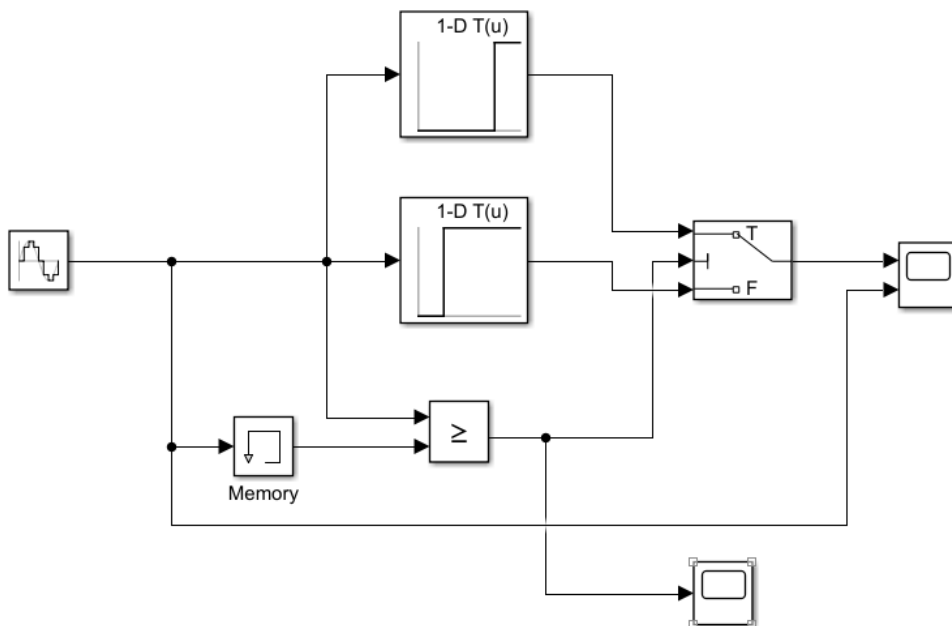
 OK Cancel Help Apply

参数设置 2



输入输出曲线

6. 单滞环继电器特性



仿真模型

Block Parameters: 1-D Lookup Table1 [X]

Lookup Table (n-D)

Perform n-dimensional interpolated table lookup including index searches. The table is a sampled representation of a function in N variables. Breakpoint sets relate the input values to positions in the table. The first dimension corresponds to the top (or left) input port.

Table and Breakpoints | Algorithm | Data Types

Number of table dimensions: 1

Data specification: Table and breakpoints

Table data: [-1 -1 1 1]

Breakpoints specification: Explicit values

Breakpoints 1: [-2 1 1.001 2]

Edit table and breakpoints...

[?] OK Cancel Help Apply

参数设置 1

Block Parameters: 1-D Lookup Table [X]

Lookup Table (n-D)

Perform n-dimensional interpolated table lookup including index searches. The table is a sampled representation of a function in N variables. Breakpoint sets relate the input values to positions in the table. The first dimension corresponds to the top (or left) input port.

Table and Breakpoints | Algorithm | Data Types

Number of table dimensions: 1

Data specification: Table and breakpoints

Table data: [-1 -1 1 1]

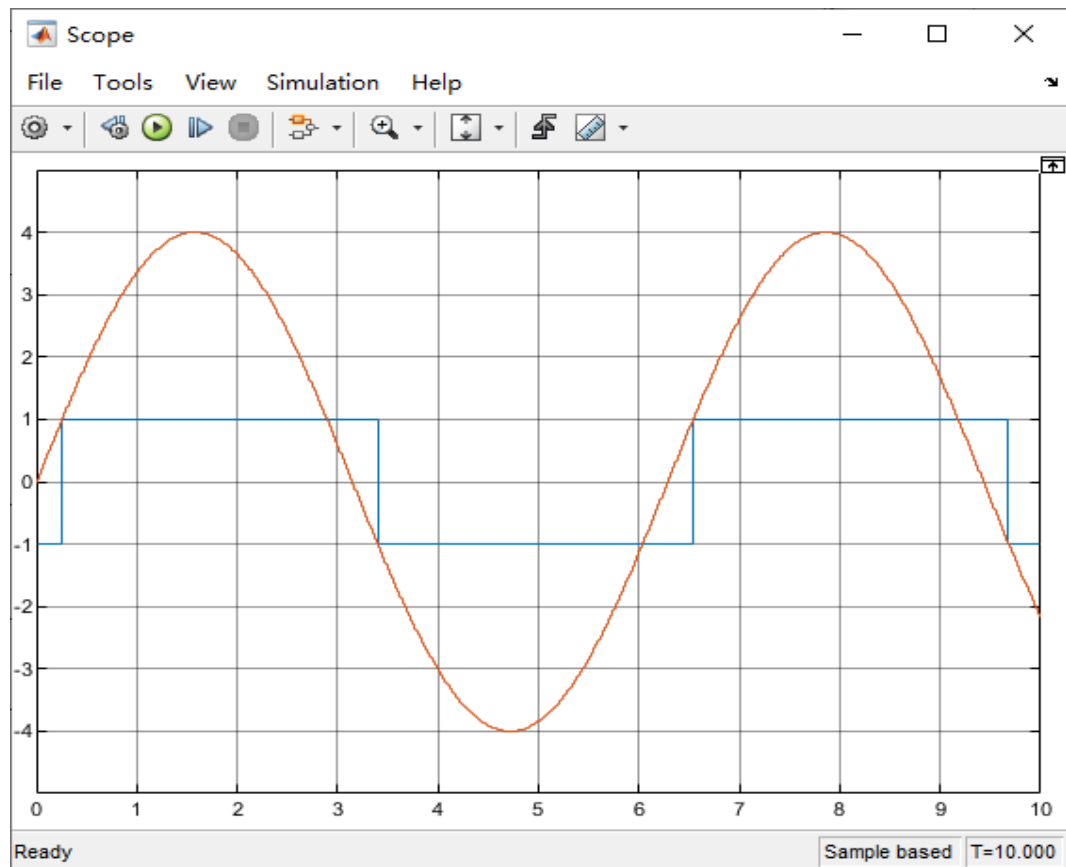
Breakpoints specification: Explicit values

Breakpoints 1: [-2 -1.001 -1 2]

Edit table and breakpoints...

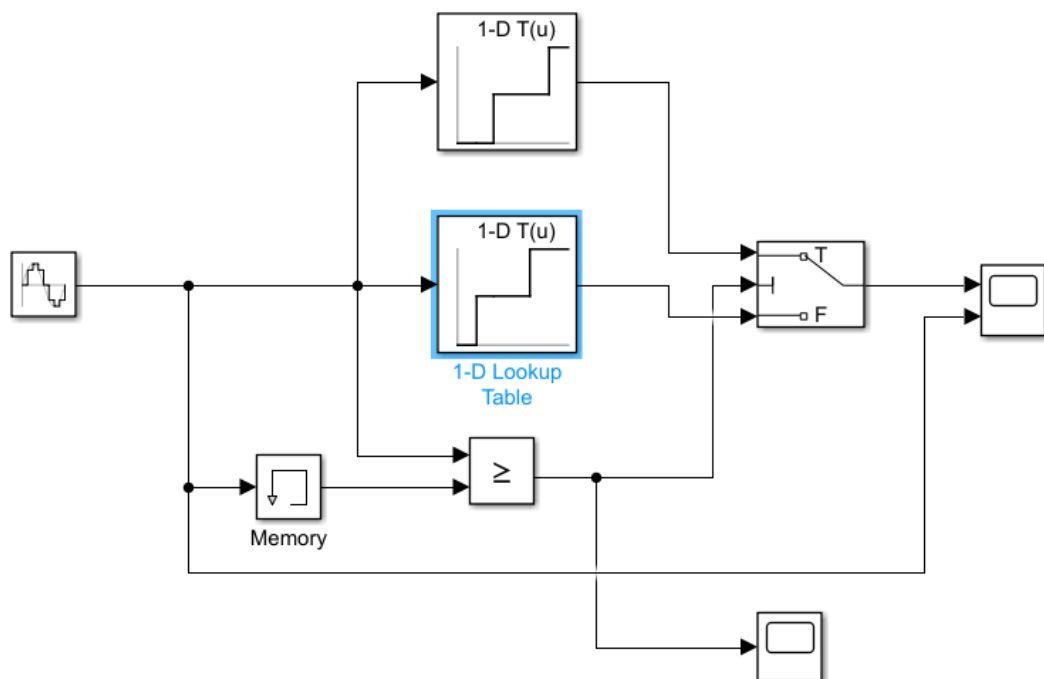
[?] OK Cancel Help Apply

参数设置 2



输入输出曲线

7. 一般继电特性



仿真模型

Block Parameters: 1-D Lookup Table1

×

Lookup Table (n-D)

Perform n-dimensional interpolated table lookup including index searches. The table is a sampled representation of a function in N variables. Breakpoint sets relate the input values to positions in the table. The first dimension corresponds to the top (or left) input port.

Table and Breakpoints

Algorithm

Data Types

Number of table dimensions: 1

Data specification: Table and breakpoints

Table data: [-1 -1 -1 0 0 1 1]

Breakpoints specification: Explicit values

Breakpoints 1: [-3 -2 -1.001 -1 2 2.001 3]

Edit table and breakpoints...

?

OK

Cancel

Help

Apply

Block Parameters: 1-D Lookup Table

×

Lookup Table (n-D)

Perform n-dimensional interpolated table lookup including index searches. The table is a sampled representation of a function in N variables. Breakpoint sets relate the input values to positions in the table. The first dimension corresponds to the top (or left) input port.

Table and Breakpoints

Algorithm

Data Types

Number of table dimensions: 1

Data specification: Table and breakpoints

Table data: [-1 -1 0 0 0 1 1]

Breakpoints specification: Explicit values

Breakpoints 1: [-3 -2.001 -2 -1 1 1.001 3]

Edit table and breakpoints...

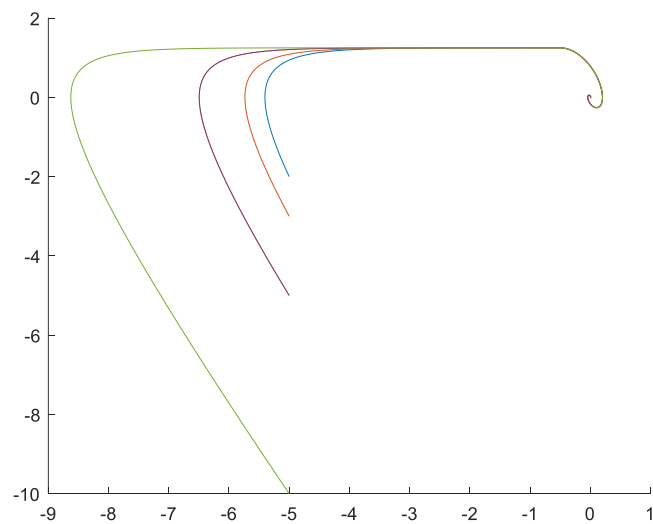
?

OK

Cancel

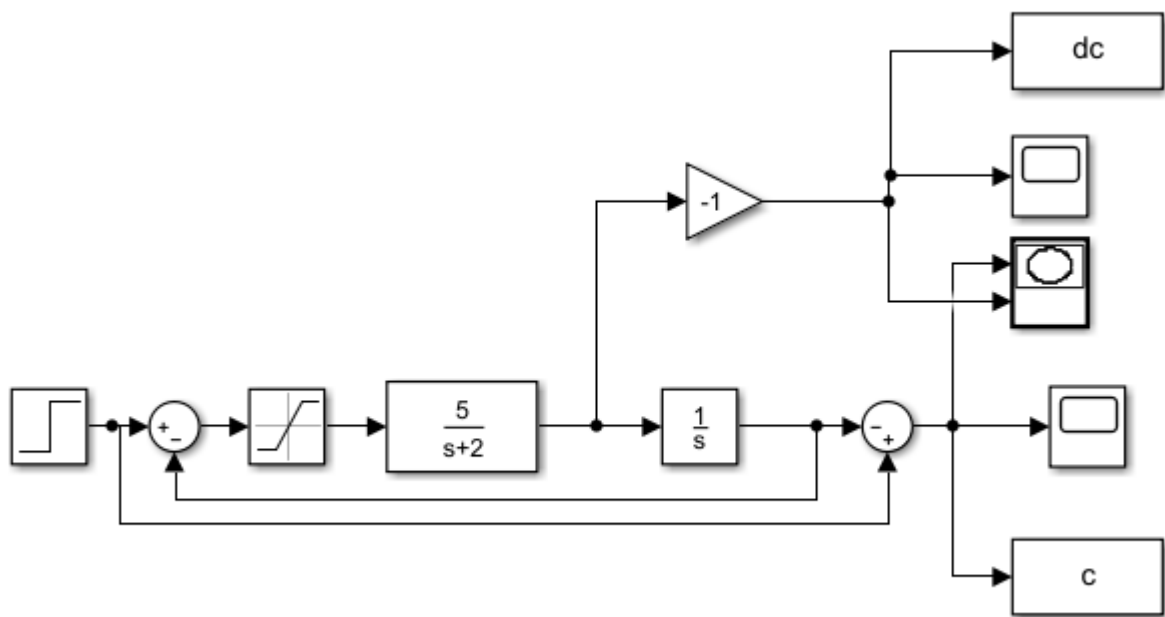
Help

Apply

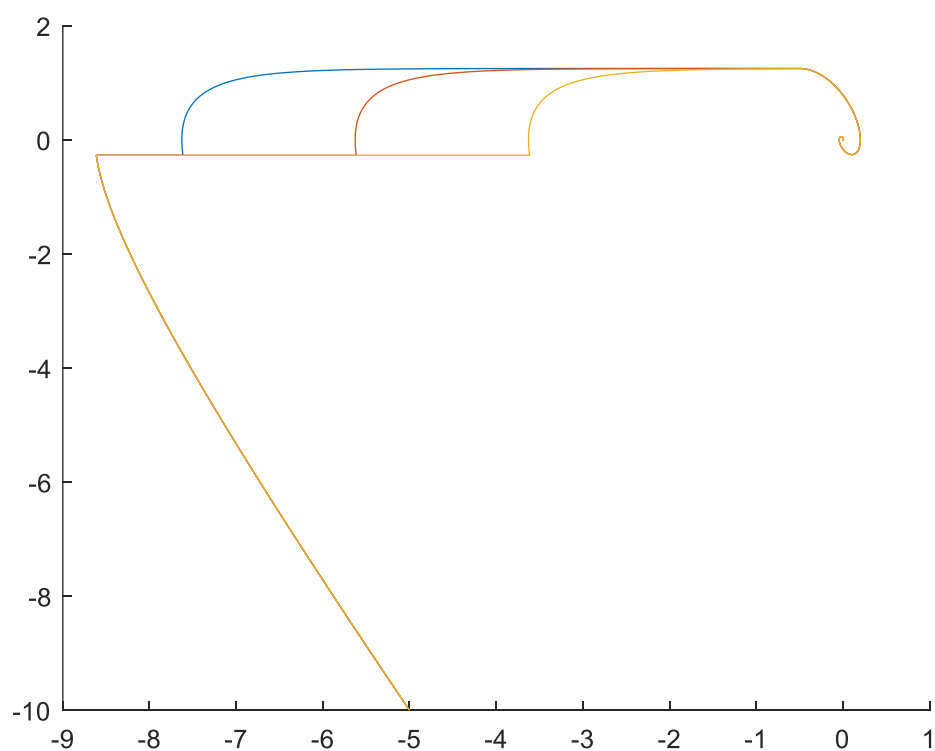


零输入相平面

四、 带有饱和特性的单位阶跃输入相平面



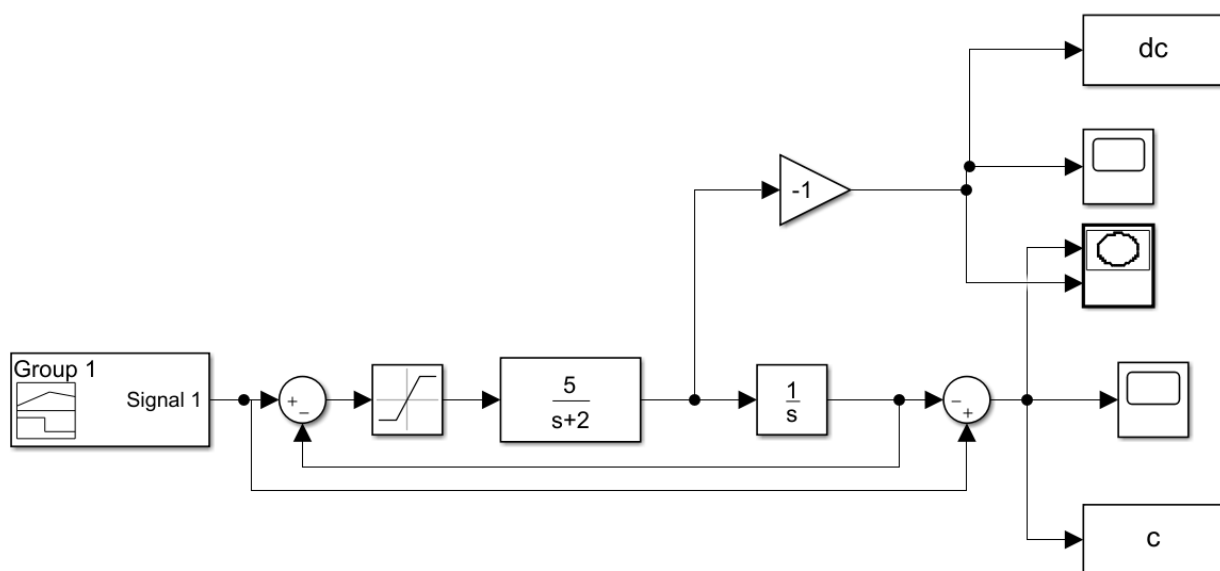
仿真模型

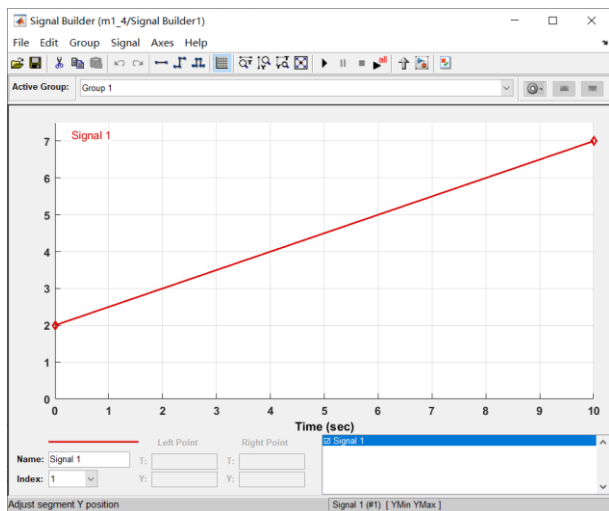


相平面图

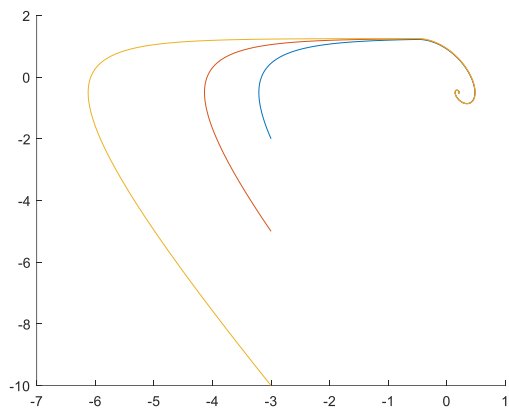
五、 带有饱和特性的系统一次函数输入相平面

取输入 $R=0.5t+2$ 为一次函数



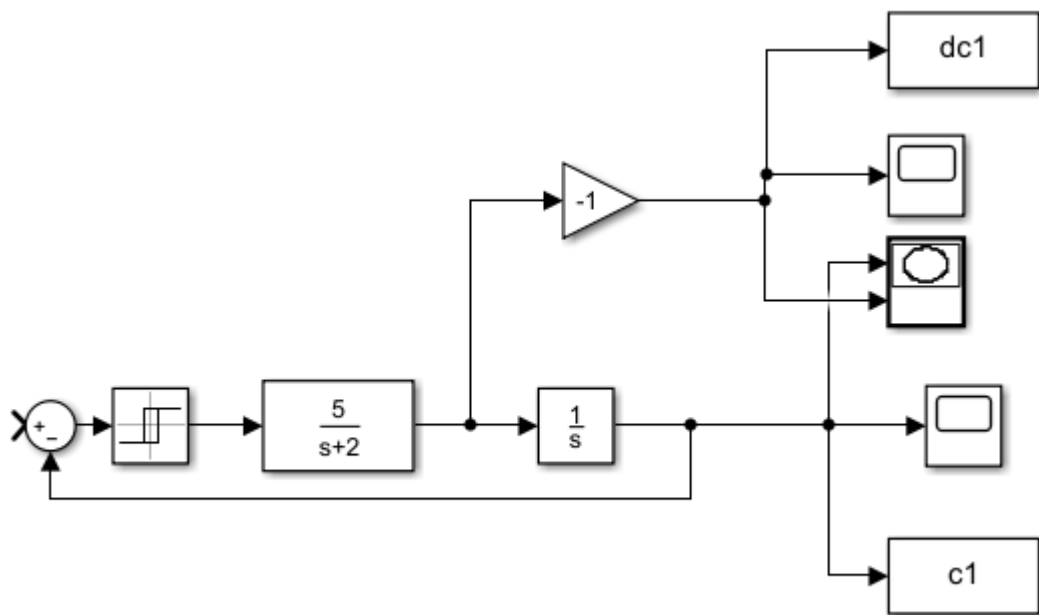


输入曲线

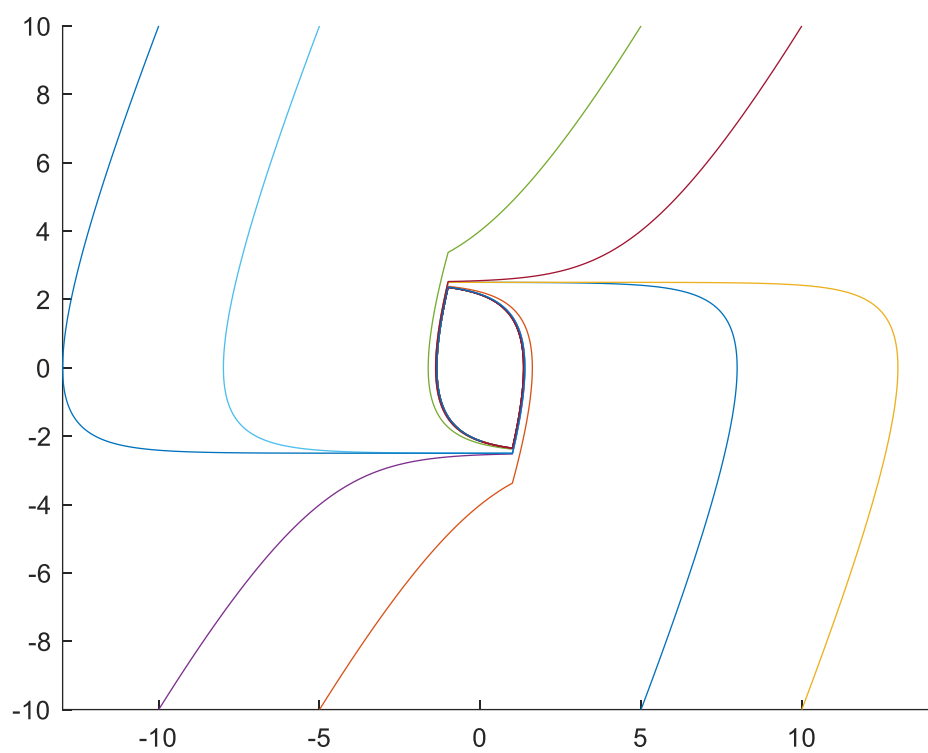


相平面图

六、 含有滞环的继电非线性特性零输入时误差的相轨迹



仿真模型



相平面图