# System modeling and simulation(ME340)

Chapter 5. state-variable models and simulation methods

5.5 Simulink and nonlinear model

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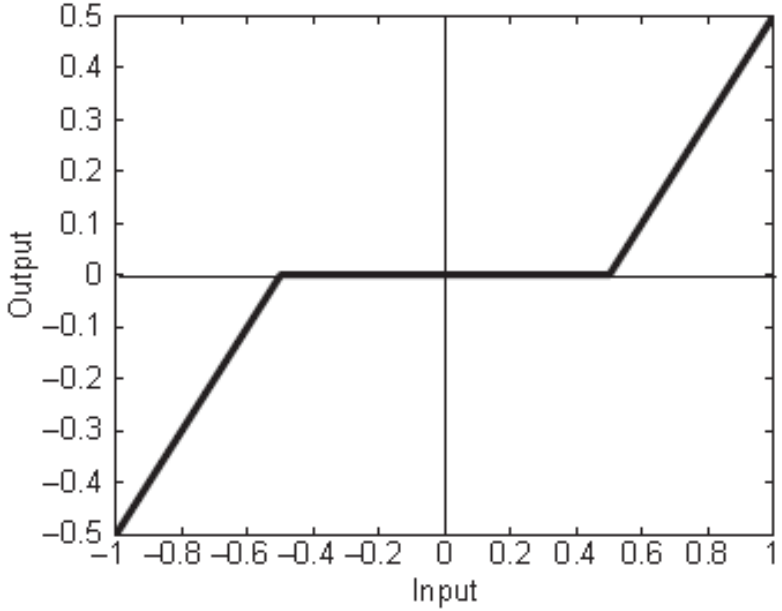
# Some properties of nonlinear dynamic systems

- They do not follow the principle of superposition (linearity and homogeneity).
- They may exhibit properties such as limit cycle, bifurcation, chaos.
- Solutions of nonlinear systems may be difficult to obtain or may not exist for all times.

$$m\ddot{y} + c\dot{y} + ky = f(t)$$

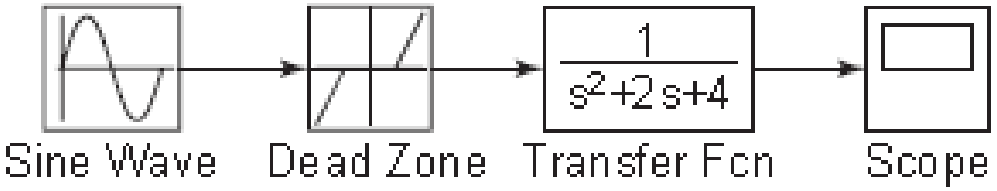
- Suppose that the force F (t) is created by applying a sinusoidal input voltage to a hydraulic piston that has a dead-zone nonlinearity. The piston does not generate a force until the input voltage exceeds a certain magnitude, and thus the system model is piecewise linear.



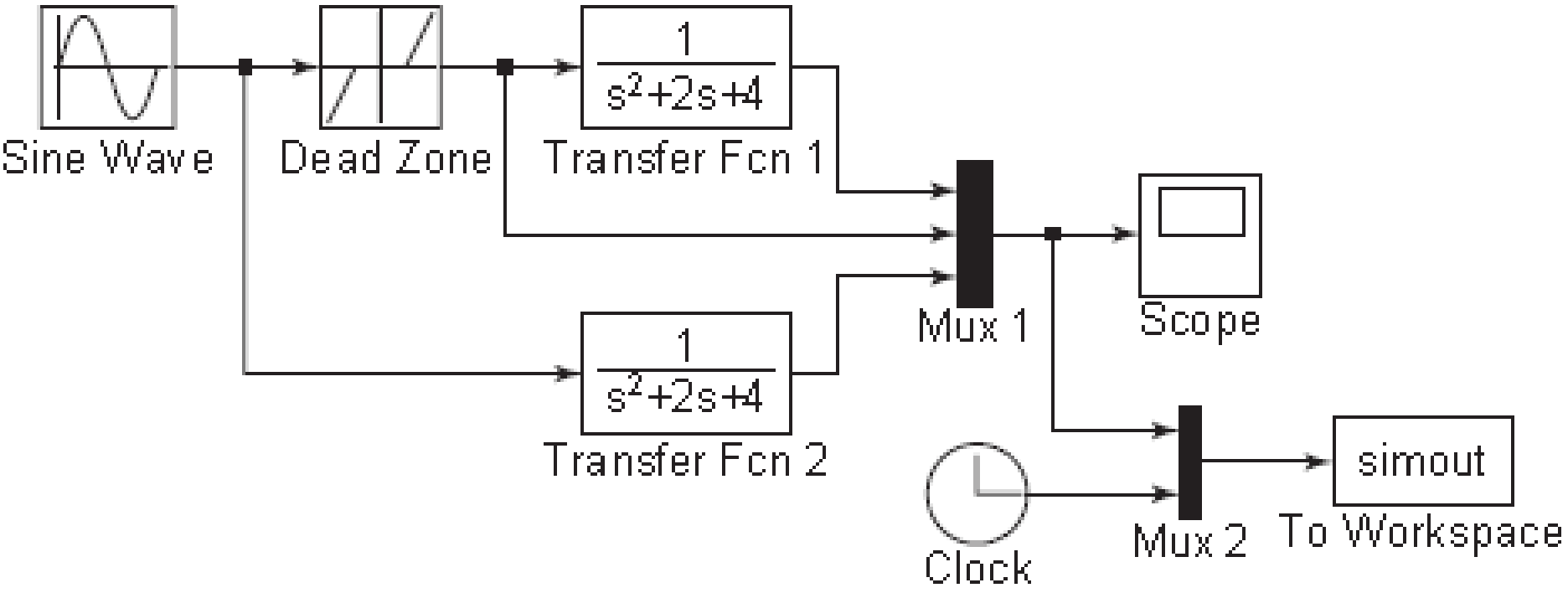
# Build a simulink model with dead zone

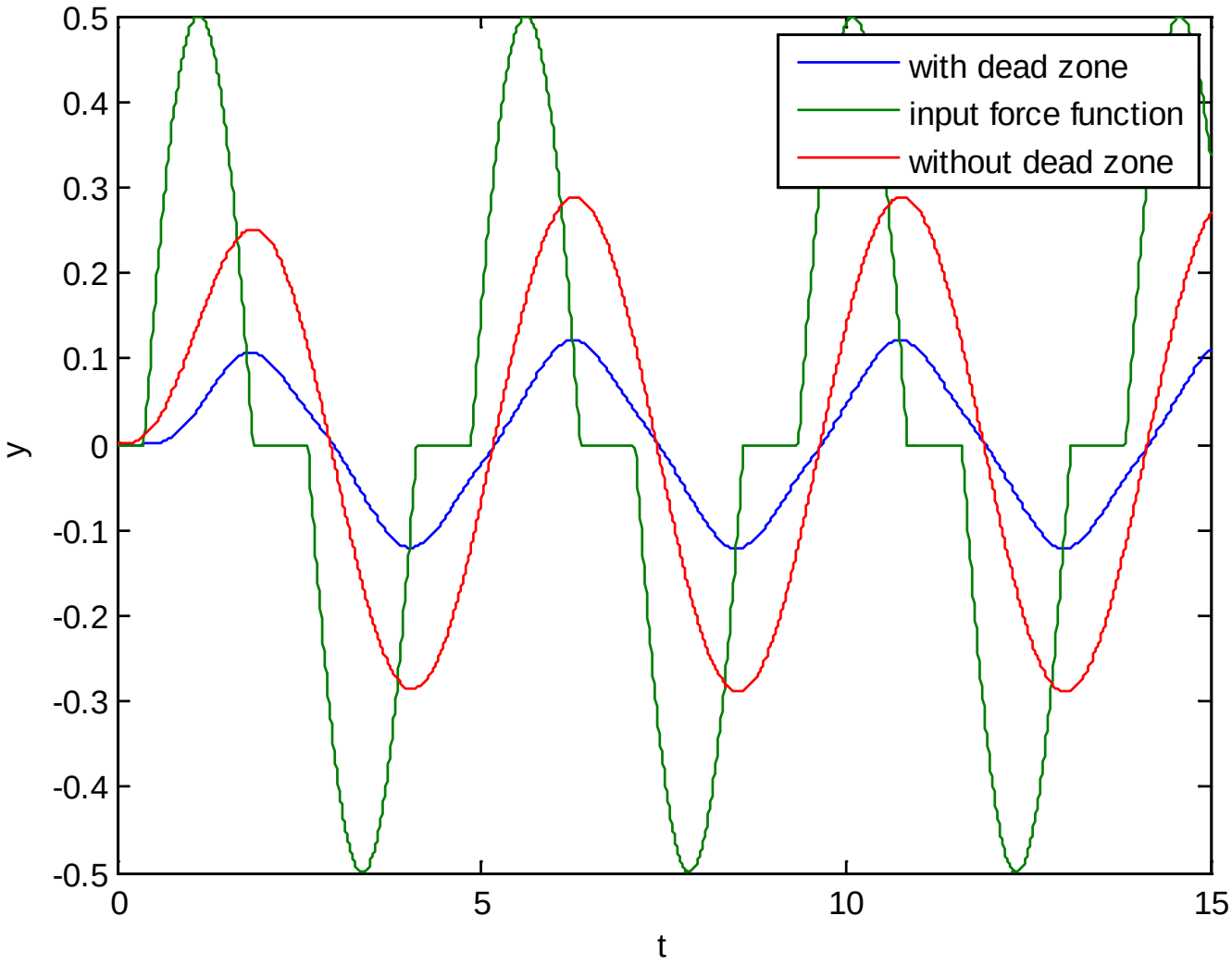
- *m =1, c=2, and k =4. The forcing function is the function f (t) = sin 1.4t.*
- The operation about the dead zone:

  Select and place the Dead Zone block from the Discontinuities category, double-click onit, and set the Start of dead zone to −0.5 and the End of dead zone to 0.5. Click OK.



# The simulation results comparison between systems with and without considering the dead zone




with dead zone
input force function
without dead zone
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
y
0
5
10
15
t

- In the Configuration Parameters submenu under the Simulation menu, you can select the ODE solver to use by clicking on the Solver tab. The default is ode45.
- Problems involving nonlinear functions such as the saturation block are much easier to solve with Simulink. In later chapters we will discover other nonlinear blocks and other advantages to using Simulink.

What you learned.

- 1. Convert a differential equation model into state-variable form.
- 2. Express a linear state-variable model in the standard vector-matrix form.
- 3. Apply the ss, ssdata, tfdata, char, eig, and initial functions to analyze linear models.
- 4. Use the MATLAB ode functions to solve linear and nonlinear differential equations.
- 5. Use Simulink to create simulations of linear and nonlinear models expressed either as differential equations or, if linear, as transfer functions.

# Homework 4

- Reading through Chapter 5
- Problems: 5.7, 5.9, 5.14, 5.18, 5.24, 5.26, 5.35
  5.36, 5.38, 5.43