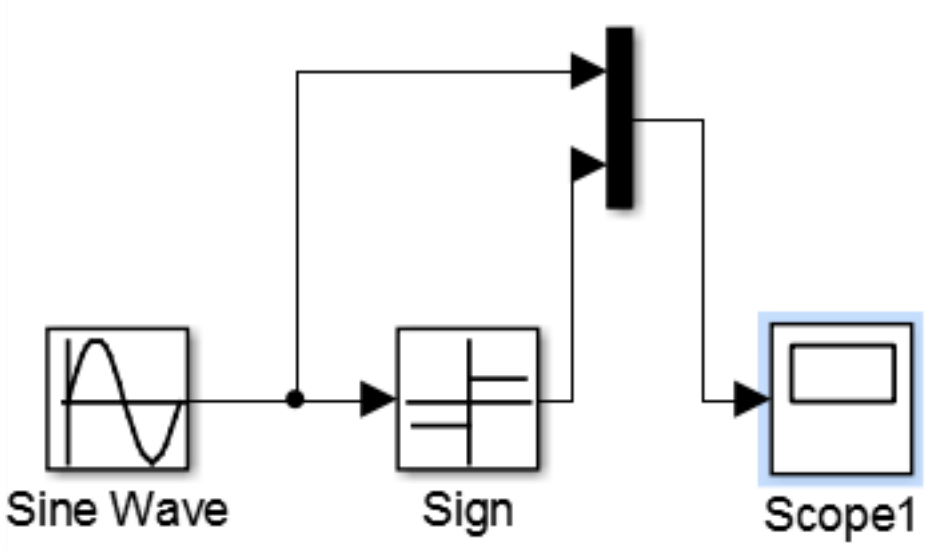
Problem 10.13:

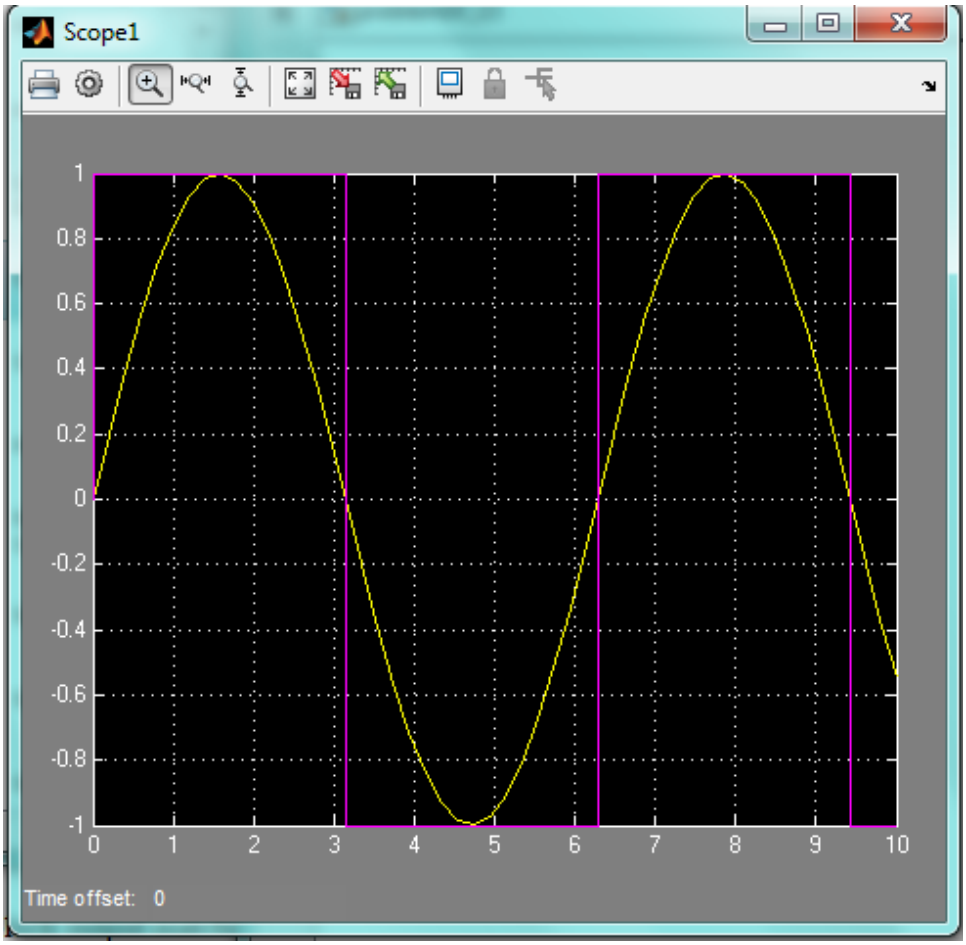
13. If a mass-spring system has Coulomb friction on the surface rather than viscous friction, its equation of motion is

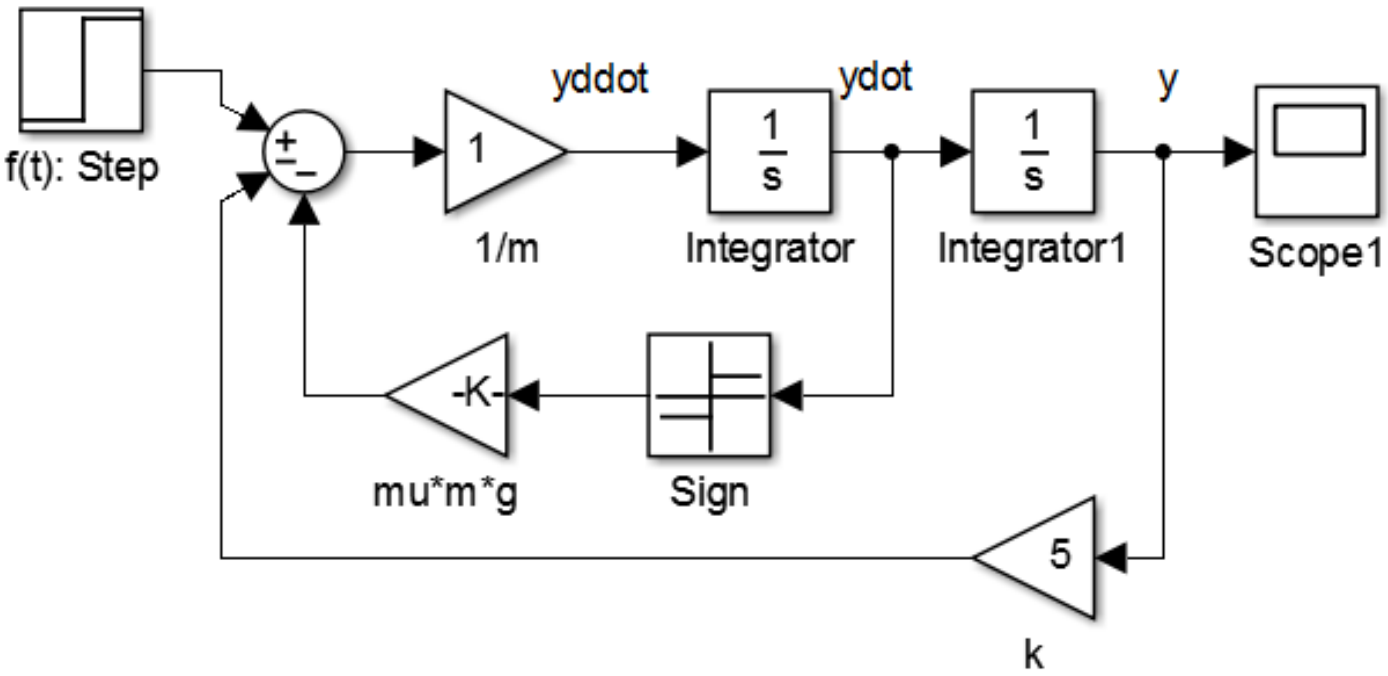
$$m\ddot{y} = \begin{cases} -ky + f(t) - \mu mg & \text{if } \dot{y} \geq 0 \\ -ky + f(t) + \mu mg & \text{if } \dot{y} < 0 \end{cases}$$

where μ is the coefficient of friction. Develop a Simulink model for the case where $m = 1\text{kg}$, $k = 5$ N/m, $\mu = 0.4$, and $g = 9.8$ m/s^2. Run the simulation for two cases: (a) the applied force $f(t)$ is a step function with a magnitude of 10 N and (b) the applied force is sinusoidal: $f(t) = 10 \sin 2.5t$. Either the Sign block in the Math Operations library or the Coulomb and Viscous Friction block in the Discontinuities library can be used, but since there is no viscous friction in this problem, the Sign block is easier to use.

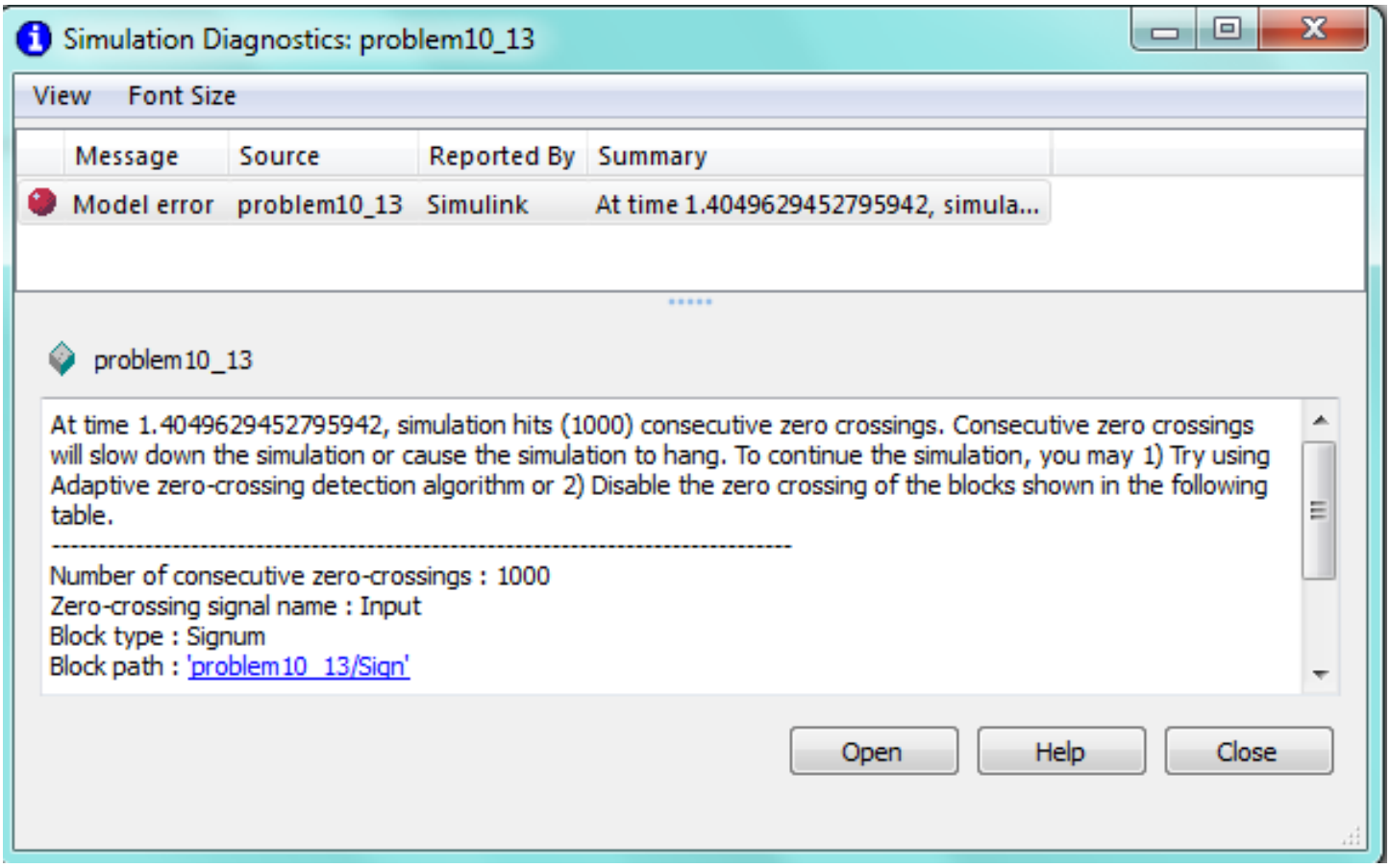
Operation of Sign Block: +1 for Input >= 0; -1 for Input < 0



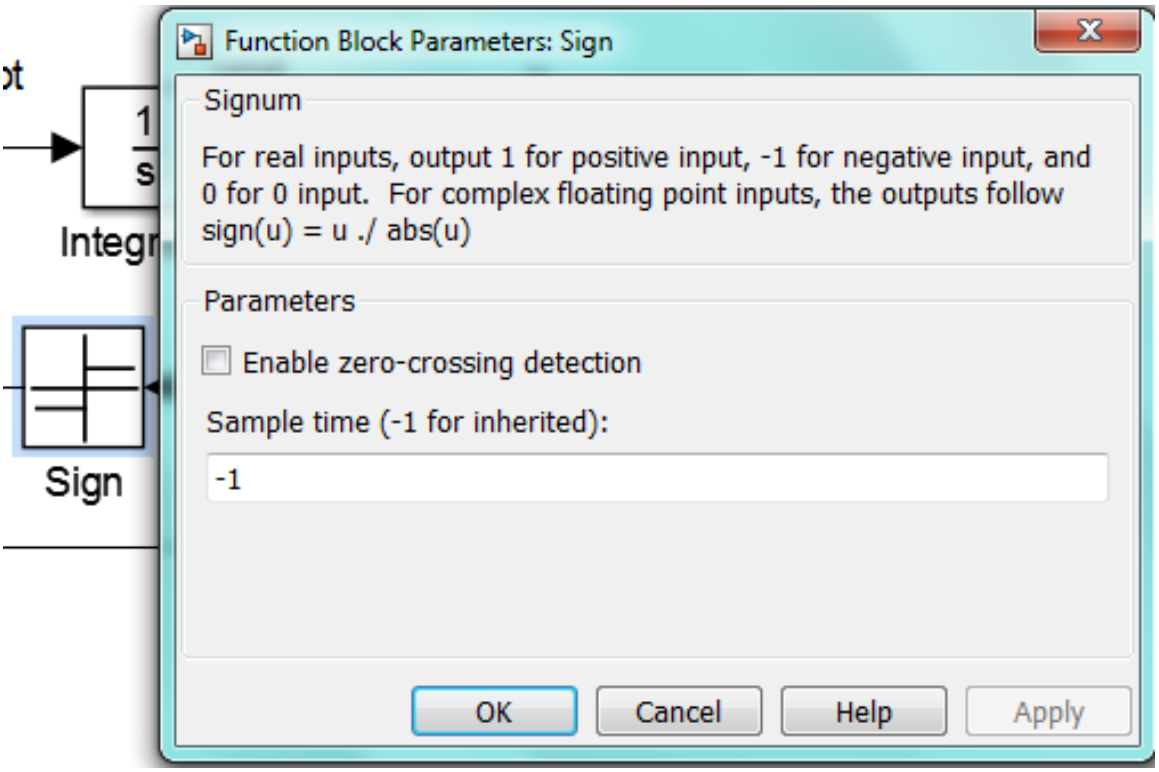


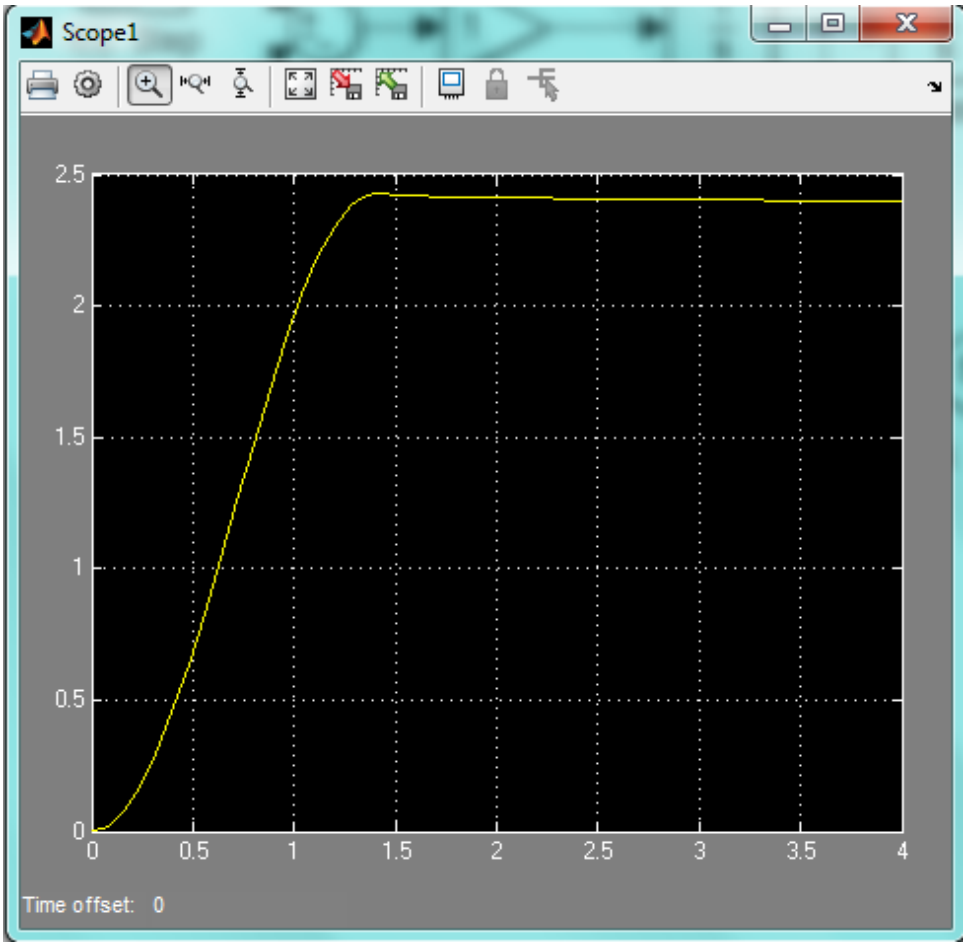


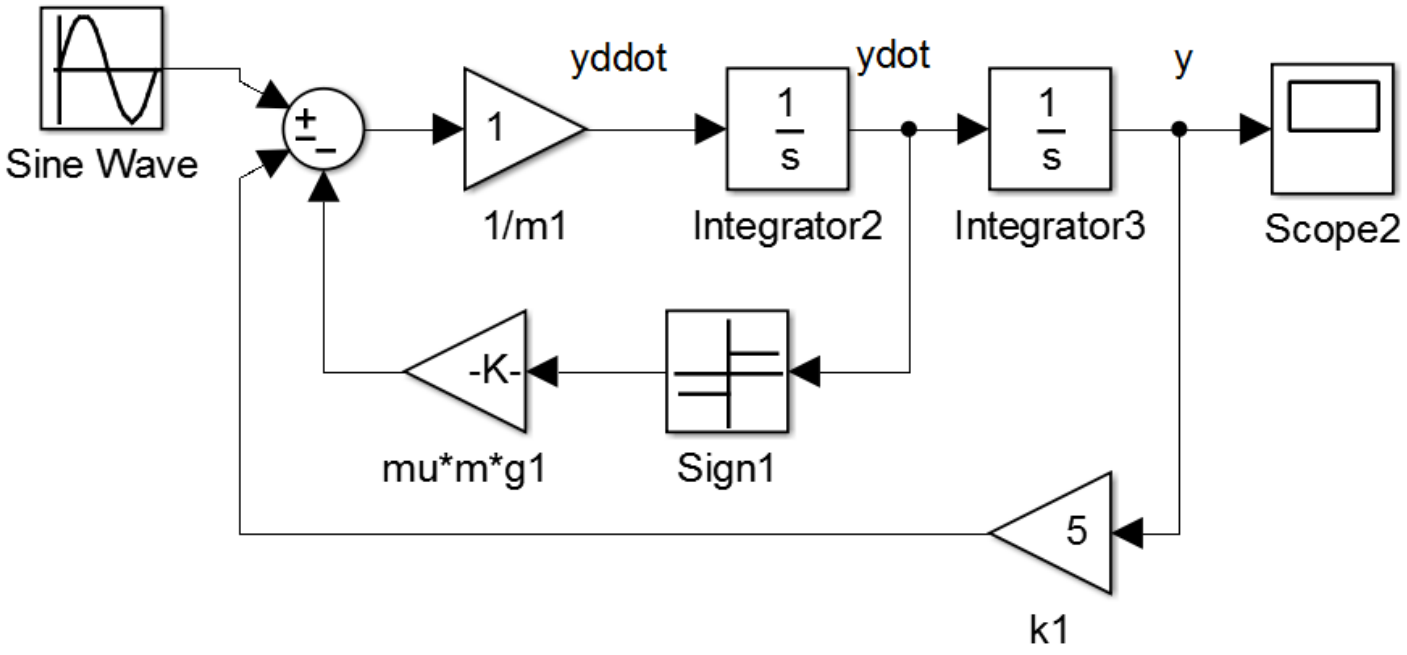
Error for t > 1.4 sec:

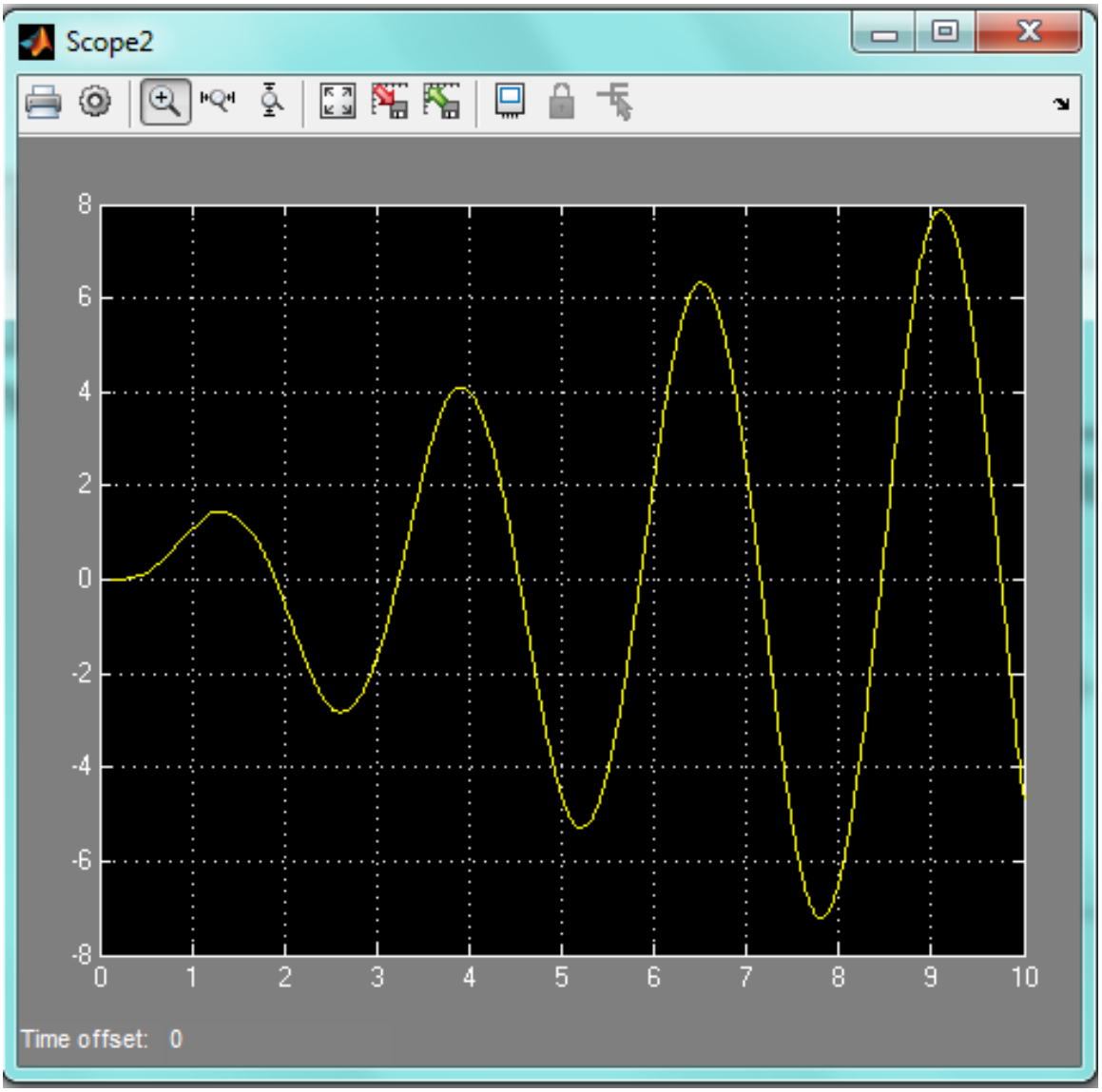


Make the following change to the Sign block:


Integr
Sign
Function Block Parameters: Sign
Signum
For real inputs, output 1 for positive input, -1 for negative input, and 0 for 0 input. For complex floating point inputs, the outputs follow sign(u) = u ./ abs(u)
Parameters
Enable zero-crossing detection
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply


Scope1
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
4
Time offset: 0


Sine Wave
1
1/m1
yddot
1
s
Integrator2
ydot
1
s
Integrator3
y
Scope2
-K-
mu*m*g1
Sign1
5
k1


Scope2
8
6
4
2
0
-2
-4
-6
-8
0
1
2
3
4
5
6
7
8
9
10
Time offset: 0