Solving Ordinary Differential Equations (ODE) with Simulink

Faculty of Technology and Bionics

Solving ODEs in Simulink – Example 1

Problem Statement

Ordinary Differential Equation (ODE)

$$\ddot{x}(t) + \omega_0{}^2 \cdot x(t) = 0$$

Initial Conditions (IC)

$$\dot{x}(t = 0) = 0$$

$$x(t = 0) = 1$$

} Initial Value Problem

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The IC models an undamped, free oszillation with eigenfrequency $\omega_0=1$.
Initially the system is in rest *dx/dt=0* for *t=0*, the initial position is *x=1*.

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Step 1

Transform the ODE into explicit form

$$\ddot{x}(t) = -\omega_0{}^2 \cdot x(t)$$

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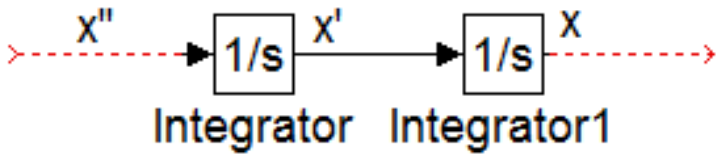
Step 2

Integrate the acceleration twice



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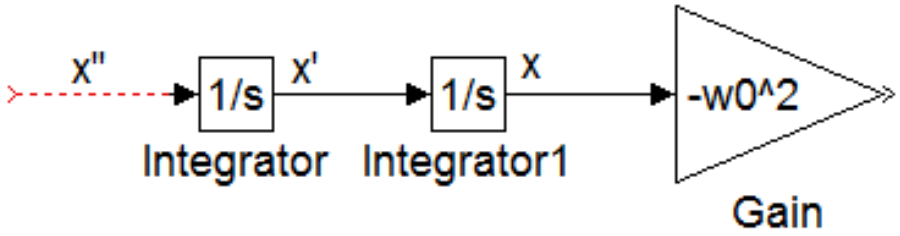
Step 3

Set up the Right-hand-Side (RHS) by use of gains, summation points etc.



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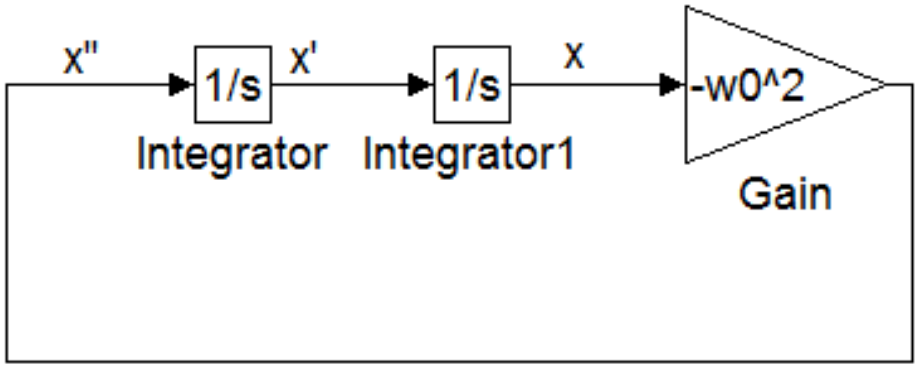
Step 4

Set up the feedback loop



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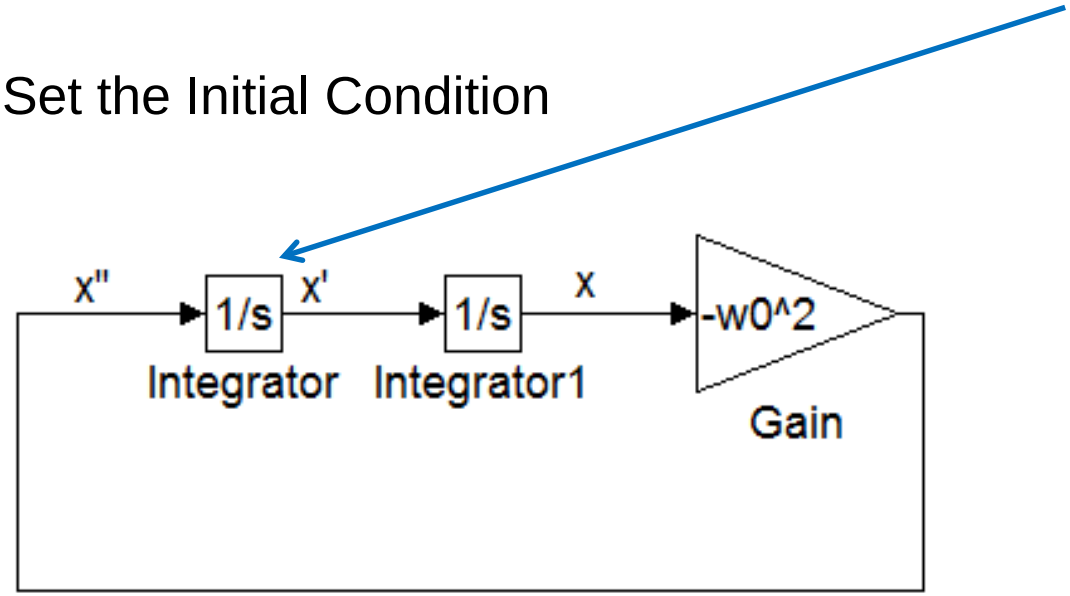
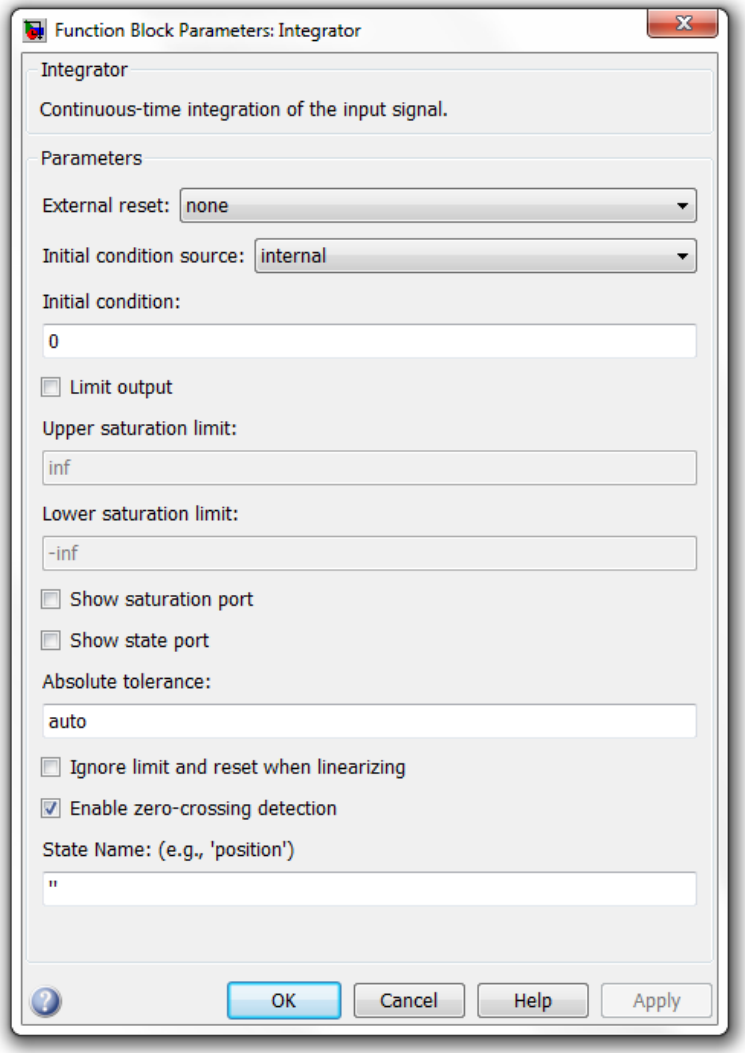
Step 5

Set the Initial Condition





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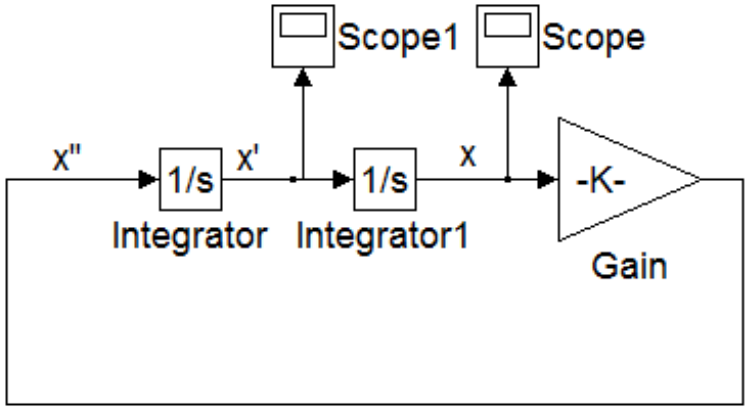
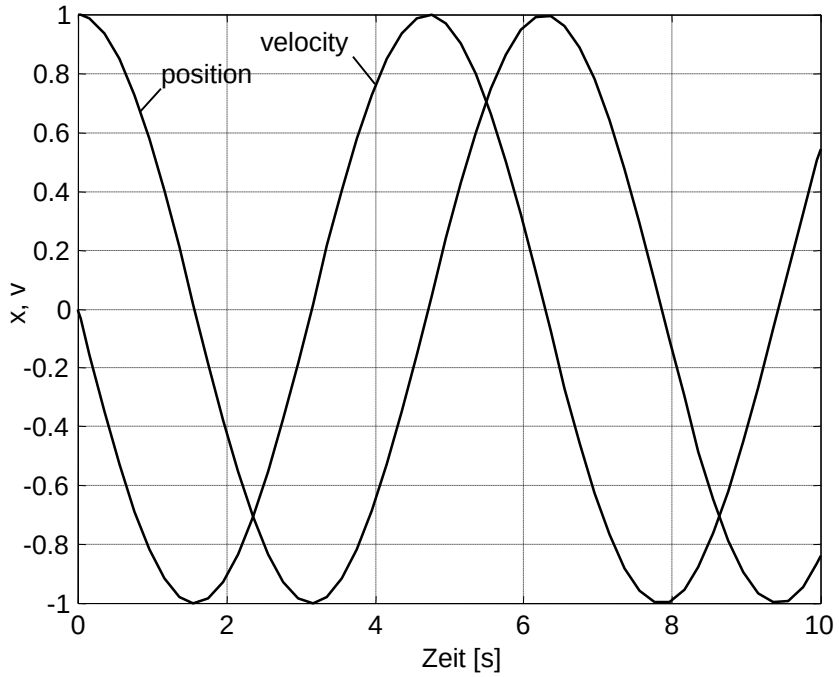
Step 6

Start Simulation and analyse results





Solving ODEs in Simulink – Example 2

Solve the following equation in Simulink:

$$\ddot{x} + d \cdot sgn(\dot{x}) \cdot \dot{x}^2 + {\omega_0}^2 \cdot x = \sin(\omega \cdot t)$$

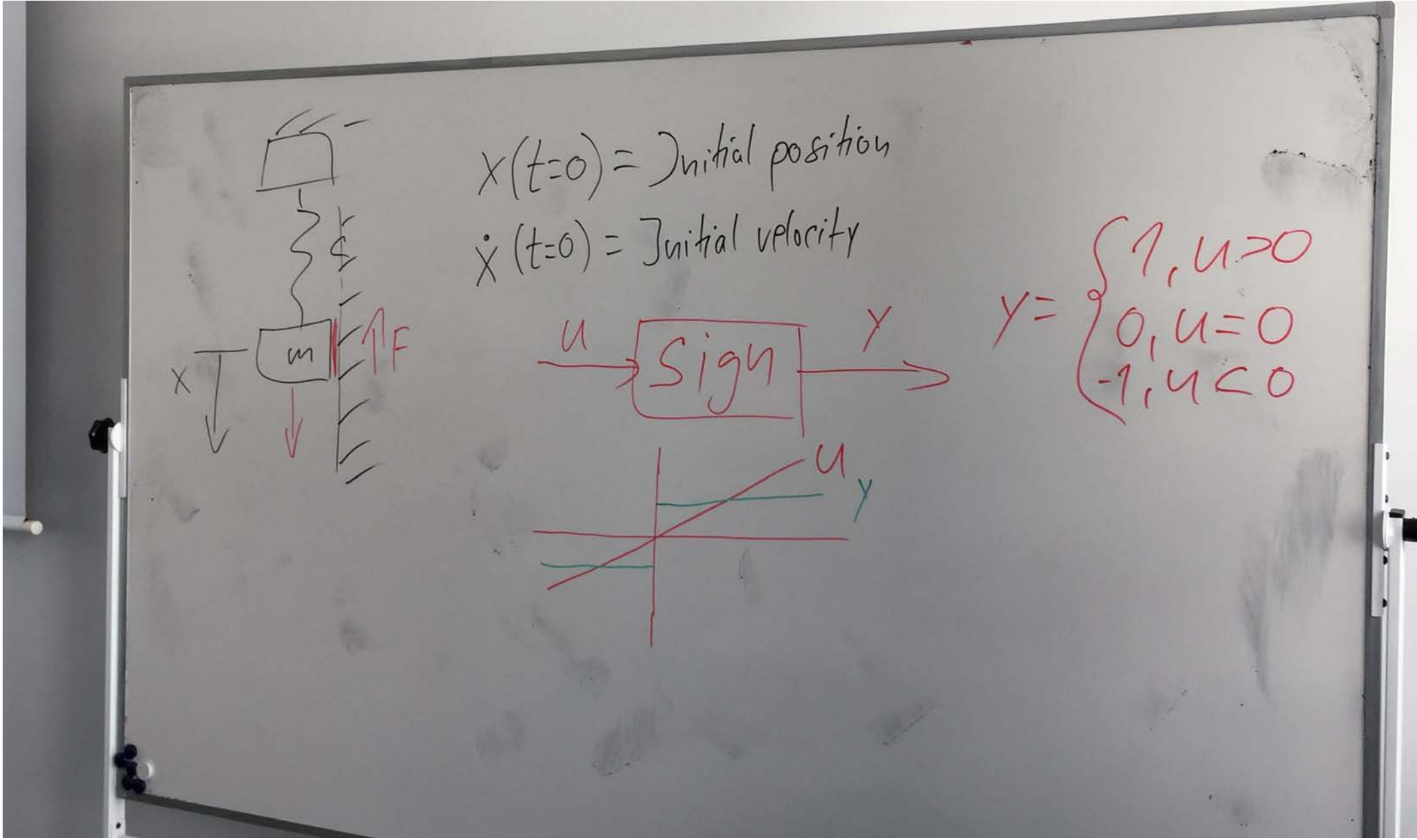
Parameter are:

ω_0^2=5

$\omega = 1$

$d=0.4$

Limit the maximal step-size of the integrator to h=0.01.



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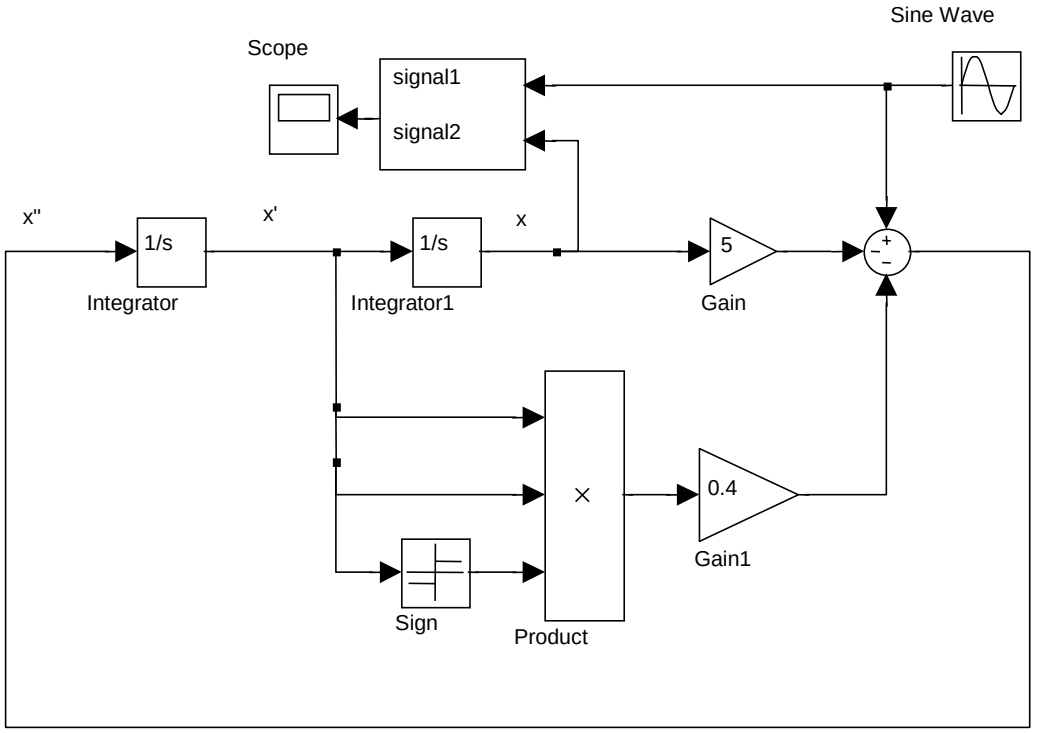
Possible block diagram



Solving ODEs in Simulink – Example 1

Simulation results