Module 7 - Damping Elements

ME3050 - Dynamics Modeling and Controls

Mechanical Engineering

Tennessee Technological University

Topic 1 - System Response

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- Solve Equation of Motion
- Free Response
- Response Equation
- Natural Frequency

We have previously derived the accepted equation of motion for this simple but fundamental system.

fancy_mass_spring.png

$$m\ddot{x} + kx = 0$$

Solve Equation of Motion

Dynamic Simulation

A simulation is an approximate imitation of the operation of a process or system;[1] that represents its operation over time. definition Wikipedia

System Analysis in the Time Domain

We study the motion and forces in the system as they change over time in response to various initial conditions and external forces.

This idea is known as the time response and we will discuss the derivations and resulting response equations for a generalized system model as we proceed (System Dynamics, Ch. 8).

Free Response

Imagine you displaced the mass, and then released it from rest.

Equation of Motion:

$$m\ddot{x} + kx = 0$$

Initial Position:

$$x(t = 0) = x(0) = x_0$$

Initial Velocity:

$$\dot{x}(t = 0) = v(0) = v_0$$

mass_spring_waxis.png

Free Response

The free response is found as the *solution the differential equation* subject to known initial conditions with zero external forced applied.

$$m\ddot{x} + kx = 0 \ , \qquad x(0) = x_0 \ , \qquad \dot{x}(0) = v_0$$

Free Response

Response Equation

$$x(t) =$$

time_axis.png

Natural Frequency

Look at the system response subject to various initial conditions. What determines the amplitude and frequency of oscillation?