

Damped Vibration User Guide, K.N. Toosi University Of Technology, ECE Faculty

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1 How To Install JRE

For running this application on your desktop computer, you must install JRE (Java Runtime Environment) on your computer.

Follow the following steps to install JRE :

- download the JRE installer by using below link.
- <http://www.oracle.com/technetwork/java/javase/downloads/jre8-downloads-2133155.html>
- choose appropriate installer for your operating system.
- then install JRE.

2 Brief Description Of Damped Vibration¹

When a "viscous" damper is added to the model this outputs a force that is proportional to the velocity of the mass. The damping is called viscous because it models the effects of a fluid within an object. The proportionality constant c

¹https://en.wikipedia.org/wiki/Vibration#Free_vibration_with_damping

is called the damping coefficient and has units of Force over velocity (lbf s/ in or N s/m).

$$F_d = -cv = -c\dot{x} = -c\frac{dx}{dt}$$

Summing the forces on the mass results in the following ordinary differential equation:

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

The solution to this equation depends on the amount of damping. If the damping is small enough, the system still vibrates—but eventually, over time, stops vibrating. This case is called underdamping, which is important in vibration analysis. If damping is increased just to the point where the system no longer oscillates, the system has reached the point of **critical damping**. If the damping is increased past critical damping, the system is overdamped. The value that the damping coefficient must reach for critical damping in the **mass spring damper model** is:

$$c_c = 2\sqrt{km}$$

To characterize the amount of damping in a system a ratio called the **damping ratio** (also known as damping factor and % critical damping) is used. This damping ratio is just a ratio of the actual damping over the amount of damping required to reach critical damping. The formula for the damping ratio (ζ) of the mass spring damper model is:

$$\zeta = \frac{c}{2\sqrt{km}}$$

For example, metal structures (e.g., airplane fuselages, engine crankshafts) have damping factors less than 0.05, while automotive suspensions are in the range of 0.2-0.3. The solution to the underdamped system for the mass spring damper model is the following:

$$x(t) = Xe^{-\zeta\omega_n t} \cos(\sqrt{1 - \zeta^2}\omega_n t - \phi), \quad \omega_n = 2\pi f_n$$

The value of X , the initial magnitude, and ϕ the **phase shift**, are determined by the amount the spring is stretched. The formulas for these values can be found in the references.

3 How To Use The Application

For using this application you must download it from followed link: <https://wp.kntu.ac.ir/aliakbarian/ode/visualizations/damped-vibration/DampedVibration.jar>

When you run the application something like figure 2 will be showed to you on the screen.

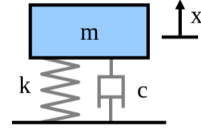


Figure 1: mass-spring damper model

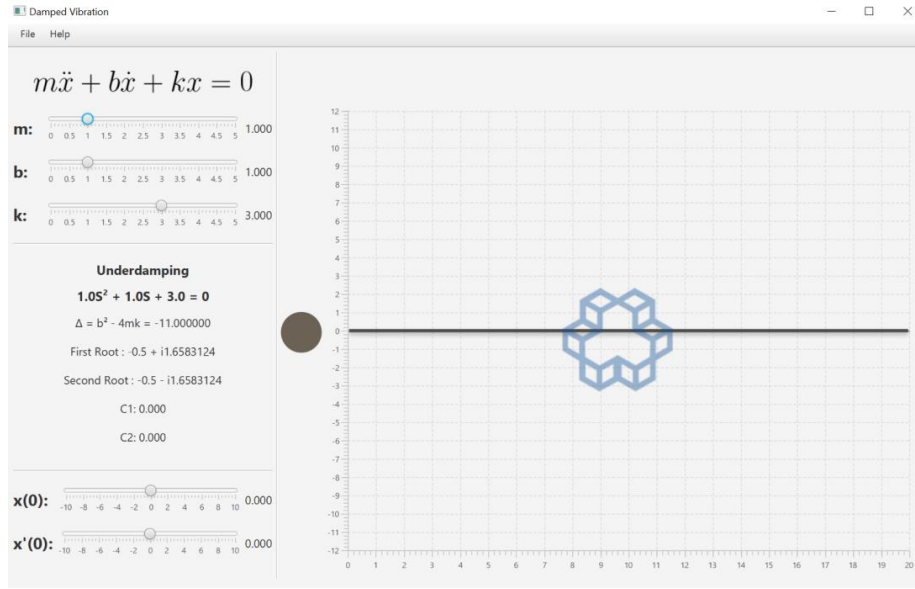


Figure 2: First Perspective

You can enter your equation by scrolling the sliders like is shown in figure 3.

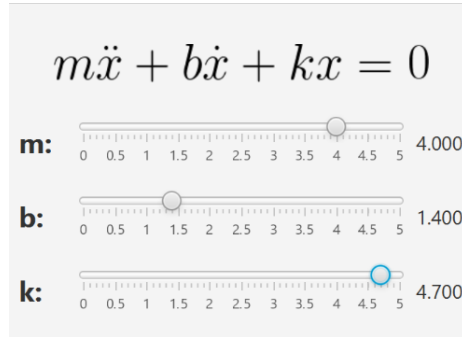


Figure 3: Equation Modifier Sliders

Then you must choose boundary condition with sliders that is shown in figure 4.

Finally the application solves the equation and gives you roots of the equation and draws the plot.

I bring some information about different sections of application in figure 5.

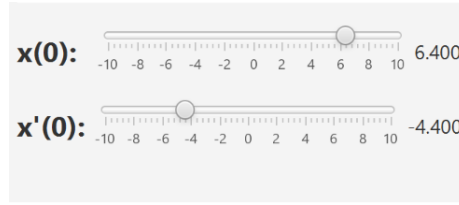


Figure 4: Boundary Condition Sliders

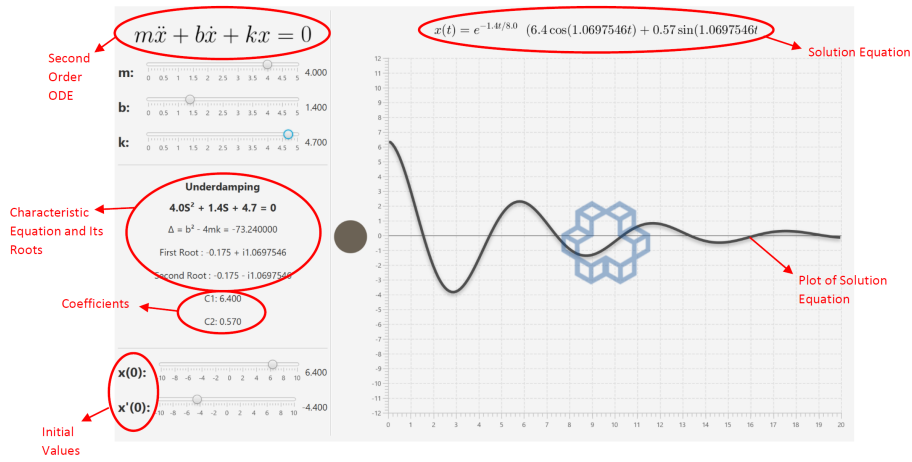


Figure 5: Description Of Application Sections

4 About Us

User guide is written by [Mahdi Kafi](#) on 5/7/2017

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