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# Vibration Attenuation of a Nonlinear Oscillator by using the Bound on the system

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## Highlights

- Lyapunov stability theory is utilized to show boundedness of the solution.
- The optimal parameters are found by estimating bound on the system.
- The proposed theory can estimate the parameters of a nonlinear autonomous system to relatively good precision and superior vibration attenuation can be predicted.

**Abstract**

This work examines dynamic optimization of an autonomous oscillator with nonlinearities in stiffness and damping. Lyapunov analysis is utilized to show boundedness of the solution. The ultimate bound on the system is found by using Lyapunov stability criterion. The optimal parameters are found by estimating the bound on the system. The proposed theory can predict the parameters of a nonlinear autonomous system to a relatively good precision and superior vibration attenuation can be predicted.

*Keywords*: Energy; Bound; Lyapunov; autonomous

## 1. Introduction

Recently many researchers have studied vibration attenuation, control, isolation and effects of negative damping in real world systems [1-14]. Lyapunov analysis can be used to show the boundedness of the solution of the state equation, even when there is no equilibrium point at the origin [15]. This work deals with dynamic optimization of autonomous nonlinear oscillator. Parmeters are estimated for superior vibration attenuation by utilizing lyapunov stability criterion. At the end numerical simulations are presented which validates the theory. In this work the differential equation with nonlinear damping and geometric nonlinearity is considered and is given by,

$$m\ddot{y} + k\,y + \delta\,y^3 + \xi\,\dot{y}(t) + \gamma\,\dot{y}^3 = 0 \qquad (1)$$

$$\ddot{y} + \omega^2\,y + k_1 y^3 + \beta_1 \dot{y}(t) + \beta_2 \dot{y}^3 = 0 \qquad (2)$$

where $\omega = \sqrt{\dfrac{k}{m}}$, $k_1 = \dfrac{\delta}{m}$, $\beta_1 = \dfrac{c_1}{m}$ and $\beta_2 = \dfrac{c_2}{m}$