

# Chapter 1

## Free Vibration of Single Degree of Freedom Linear Oscillator

### ABSTRACT

*This chapter is dedicated to understanding and studying a didactic case represented by a free vibration of a linear oscillator with a single degree of freedom. Mathematical equations of the problem will be detailed as well as the solution that goes with single degree of freedom oscillator for translational vibration for all cases: free undamped oscillator, as well as free damped oscillator, and torsional free undamped vibration passing by critical, subcritical, and over damping system. At the end of the chapter, some examples will be treated.*

### INTRODUCTION

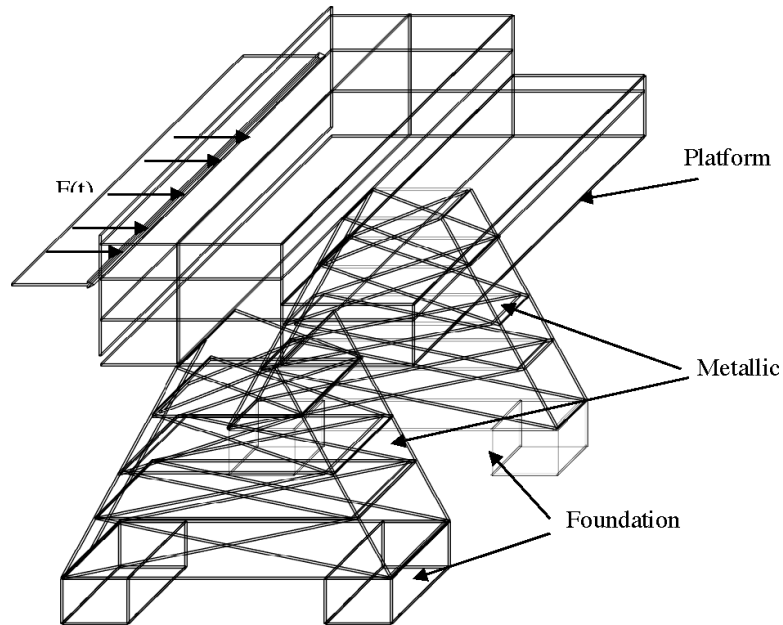
This chapter is devoted solely to the development of all equations concerning construction of an analytical as well as mathematical model of a free vibration system linear oscillator.

All structures are complex because a structure contains several elements, the simplest element contains two nodes and each node has six degree of freedom (dof), three displacements and three rotations. The goal is to try to minimize the number of these equations.

To reduce the number of equations, we will make a simple mathematical model that will reflect as much as possible the real structure shown in Figure 1.

In this case, a column with the same physical and mechanical characteristics replaces the metallic structure, and the mass  $M$  replaces the platform (see Figure 2).

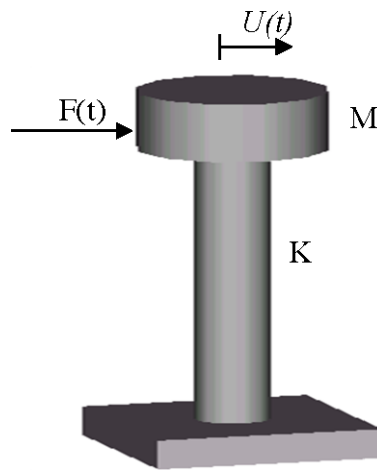
Figure 1. Complex structure



## DYNAMIC MOTION EQUATION OF A FREE UNDAMPED OSCILLATOR

The simplest vibrating mechanical system is constituted by a point mass  $m$ , subject to frictionless displacement on an axis  $Ox$ . The spring force of a stiffness  $K$  and a neglected mass is the only force exerted on this mass (see figure 2). This system has a single degree of freedom because the position of the mass  $m$  is represented by a single variable  $U(t)$  which is the variation of  $m$  with respect to its equilibrium position.

Figure 2. Simplest model (mass stiffness)



38 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

[www.igi-global.com/chapter/free-vibration-of-single-degree-of-freedom-linear-oscillator/273506](http://www.igi-global.com/chapter/free-vibration-of-single-degree-of-freedom-linear-oscillator/273506)

## Related Content

---

### Definition of nZEB Renovation Standard

Szymon Firlg (2018). *Design Solutions for nZEB Retrofit Buildings* (pp. 1-23).

[www.irma-international.org/chapter/definition-of-nzeb-renovation-standard/199584](http://www.irma-international.org/chapter/definition-of-nzeb-renovation-standard/199584)

### Analyzing Intercity Modal Choice and Competition Between High Speed Rail (HSR) and Other Transport Modes in Indian Context

Ashish Verma and Varun Raturi (2016). *Handbook of Research on Emerging Innovations in Rail Transportation Engineering* (pp. 146-160).

[www.irma-international.org/chapter/analyzing-intercity-modal-choice-and-competition-between-high-speed-rail-hsr-and-other-transport-modes-in-indian-context/154413](http://www.irma-international.org/chapter/analyzing-intercity-modal-choice-and-competition-between-high-speed-rail-hsr-and-other-transport-modes-in-indian-context/154413)

### 3XE: Efficiency, Ecosphere, Economics

Elzbieta Dagny Rynska (2018). *Design Solutions for nZEB Retrofit Buildings* (pp. 98-114).

[www.irma-international.org/chapter/3xe/199587](http://www.irma-international.org/chapter/3xe/199587)

### Performance of a Post-Byzantine Triple-Domed Basilica under Near and Far Fault Seismic Loads: Analysis and Intervention

Constantine C. Spyarakos, Charilaos A. Maniatakis, Panagiotis Kiriakopoulos, Alessio Francioso and Ioannis M. Taflampas (2015). *Handbook of Research on Seismic Assessment and Rehabilitation of Historic Structures* (pp. 831-867).

[www.irma-international.org/chapter/performance-of-a-post-byzantine-triple-domed-basilica-under-near-and-far-fault-seismic-loads/133370](http://www.irma-international.org/chapter/performance-of-a-post-byzantine-triple-domed-basilica-under-near-and-far-fault-seismic-loads/133370)

### Introduction

(2017). *Design Solutions and Innovations in Temporary Structures* (pp. 1-11).

[www.irma-international.org/chapter/introduction/177364](http://www.irma-international.org/chapter/introduction/177364)