Chapter 1
Analysis and Modeling of Vibrations and Dynamic States in Technical Systems:
Forms of Interaction Between Elements

ABSTRACT

The issues of vibration interactions, dynamic states and forms of interaction of elements in technical objects with an emphasis on modern mechanical engineering are considered. Basic methods such as the use of systems of equations related to the dynamic state are discussed, as well as a special focus on interdisciplinary interactions applied in robotics and mechatronics. It has been shown that modern technical systems require detailed descriptions, which leads to the use of idealized calculation schemes that help in the analysis and prediction of machine behavior under the influence of dynamic influences. Thus, the need for a systematic approach to the analysis and design of vibration properties of technical objects is justified, which requires the use of interdisciplinary methods, the latest mathematical and computational technologies.

INTRODUCTION

Modern machine science is a complex scientific and technical direction, closely connected in its interdisciplinary interactions with the theory of mechanisms and machines, the dynamics and strength of machines, instruments and equipment. In

DOI: 10.4018/979-8-3373-0447-2.ch001

recent years, methods of rational design and construction of machines, drives and their components have received significant development. This was reflected in the use of the methodological basis of theoretical mechanics, the theory of oscillations, which provide opportunities for the development of methods of system analysis and mathematical modeling in solving problems related to the corresponding calculations of machines, mechanisms and parts for reliability, endurance, vibration stability, etc.

Vibrations in the operation of technological and transport machines are quite multifaceted and their influence can lead to negative consequences, which stimulates the development of theoretical foundations in the methods of calculating machines, mechanisms and their parts, as well as methods and means of protection against vibrations and control of the dynamic state of machines as a whole.

The variety of solved problems predetermined the development of theoretical approaches and methods of mathematical modeling, among which methods of computational modeling using MatLab, MathCad, ANSYS, Maple and other application packages occupy a prominent place.

Modern machine science is an actively developing scientific field, in which more and more attention is paid to detailing ideas about the dynamic properties of machines from nodes and parts obtained on the basis of mathematical modeling. The basis of such approaches is the preliminary development and refinement of physical models, which most often take the form of mechanical oscillatory systems of one complexity or another. Such approaches are based on the idea that the studied models have a well-defined adequacy in relation to real processes, and typical elements of mechanical oscillatory systems are correlated with real prototypes of machine parts and mechanisms.

At the stages of preliminary research and subsequent design and calculations of technical objects - machines, equipment and their components, quite often there is a need to draw up idealized and simplified schemes, which could reflect the features of the physical nature of the elements, connections and structure essential for the tasks being solved, in general. For mathematical analysis and subsequent calculations, it is necessary to take into account the main factors that determine the dynamic state of a certain mechanical system, which generally contains elements and nodes of devices of different physical nature. The calculation scheme precedes the subsequent stage associated with the creation of a mathematical model.

In recent years, the dynamics of machines has been actively developing in a number of areas that are associated with the widespread use of methods of the theory of automatic control. This is reflected in the solution of theoretical and practical issues in robotics, mechatronics, vibration diagnostics, the development of methods and means to ensure the reliability and safety of the operation of complex technical objects. Considerable attention is paid to the tasks of protecting machines, equipment and apparatus from vibration external influences, which stimulates the development

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Taha-Hossein Hejaziand Hossein Poursabbagh (2017). *Mathematical Concepts and Applications in Mechanical Engineering and Mechatronics (pp. 154-176).*
www.irma-international.org/chapter/reliability-analysis-of-engineering-systems/170156