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Vibration Damping, Control, and Design

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Preface

In individual chapters authored by distinguished leaders and experienced professionals in their respective topics, this book provides for engineers, technicians, designers, researchers, educators, and students, a convenient, thorough, up-to-date, and authoritative reference source on techniques, tools, and data for analysis, design, monitoring and control of vibration, noise, and acoustics. Vibration suppression, damping, and control; design for and control of vibration; system design, application, and control implementation; and acoustics and noise suppression are treated in the book. Important information and results are summarized as windows, tables, graphs, and lists throughout the chapters, for easy reference and information tracking. References are given at the end of each chapter, for further information and study. Cross-referencing is used throughout to indicate other places in the book where further information on a particular topic is provided.

In the book, equal emphasis is given to theory and practical application. Analytical formulations, design approaches, and control techniques are presented and illustrated. Examples and case studies are given throughout the book to illustrate the use and application of the included information. The material is presented in a format that is convenient for easy reference and recollection.

Mechanical vibration is a manifestation of the oscillatory behavior in mechanical systems as a result of either the repetitive interchange of kinetic and potential energies among components in the system, or a forcing excitation that is oscillatory. Such oscillatory responses are not limited to purely mechanical systems, and are found in electrical and fluid systems as well. In purely thermal systems, however, free natural oscillations are not possible, and an oscillatory excitation is needed to obtain an oscillatory response. Sound, noise, and acoustics are manifestations of pressure waves, sources of which are often vibratory dynamic systems.

Low levels of vibration mean reduced noise and improved work environment. Vibration modification and control can be crucial in maintaining high performance and production efficiency, and prolonging the useful life in industrial machinery. Consequently, a considerable effort is devoted today to studying and controlling the vibration generated by machinery components, machine tools, transit vehicles, impact processes, civil engineering structures, fluid flow systems, and aircraft. Noise and acoustic problems can originate from undesirable vibrations and fluid–structure interactions, as found, for example in automobile engines. Noises from engine, environment, and high-speed and high-temperature exhaust gases in a vehicle will not only cause passenger discomfort and public annoyance, but also will result in damaging effects to the vehicle itself. Noise suppression methods and devices, and sound absorption material and structures are crucial under such situations. Before designing or controlling a system for good vibratory or acoustic performance, it is important to understand, analyze, and represent the dynamic characteristics of the system. This may be accomplished through purely analytical means, computer analysis of analytical models, testing and analysis of test data, or by a combination of these approaches.

In recent years, educators, researchers, and practitioners have devoted considerable effort towards studying and controlling vibration and noise in a range of applications in various branches of

engineering, particularly, civil, mechanical, aeronautical and aerospace, and production and manufacturing. Specific applications are found in machine tools, transit vehicles, impact processes, civil engineering structures, construction machinery, industrial processes, product qualification and quality control, fluid flow systems, ships, and aircraft. This book is a contribution towards these efforts. In view of these analytical methods, practical considerations, design issues, and experimental techniques are presented throughout the book, and in view of the simplified and snap-shot style presentation of formulas, data, and advanced theory, the book serves as a useful reference tool and an extensive information source for engineers and technicians in industry and laboratories, researchers, instructors, and students in the areas of vibration, shock, noise, and acoustics.

Clarence W. de Silva

Editor-in-Chief
Vancouver, Canada

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Editor-in-Chief

Dr. Clarence W. de Silva, P.Eng., Fellow ASME, Fellow IEEE, Fellow Canadian Academy of Engineering, is Professor of Mechanical Engineering at the University of British Columbia, Vancouver, Canada, and has occupied the NSERC-BC Packers Research Chair in Industrial Automation since 1988. He has earned Ph.D. degrees from the Massachusetts Institute of Technology and the University of Cambridge, England. De Silva has also occupied the Mobil Endowed Chair Professorship in the Department of Electrical and Computer Engineering at the National University of Singapore. He has served as a consultant to several companies including IBM and Westinghouse in the U.S., and has led the development of eight industrial machines and devices. He is recipient of the Henry M. Paynter Outstanding Investigator Award from the Dynamic Systems and Control Division of the American Society of Mechanical Engineers (ASME), Killam Research Prize, Lifetime Achievement Award from the World Automation Congress, Outstanding Engineering Educator Award of IEEE Canada, Yasurdo Takahashi Education Award of the Dynamic Systems and Control Division of ASME, IEEE Third Millennium Medal, Meritorious Achievement Award of the Association of Professional Engineers of BC, and the Outstanding Contribution Award of the Systems, Man, and Cybernetics Society of the Institute of Electrical and Electronics Engineers (IEEE).

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