Preface

Essentials of Structural Dynamics is intended to provide students and practitioners with a clear and concise presentation of structural dynamics. It begins with an overview of foundational concepts and methods (e.g., idealization of structures, degrees of freedom, determining mass and stiffness of structures and structural elements, types of force excitation, etc.) used throughout the book. In Chap. 2, we examine the formulation of the equation of motion for a single-degree-of-freedom (SDOF) oscillator along with the solution to the differential equation of motion for unloaded SDOF undamped and damped systems (free vibration response). Next, we present the solution for forced SDOF undamped and damped systems: harmonic forcing function in Chap. 3 and general forcing function in Chap. 4, where we also include several computational tools that are used to solve the complex mathematics involved in the solution of the equation of motion. In these first four chapters, the primary focus is on developing parameters to characterize structural system mass, stiffness, and damping, which, in turn, are used to calculate periods, frequencies, and other relevant dynamic properties such as dynamic internal forces in structures at a particular location.

We then connect the analysis of multi-degree-of-freedom (MDOF) systems to fundamental SDOF principles through the development of the generalized SDOF equations (Chap. 5). This generalized SDOF formulation can be combined with the principles associated with SDOF analyses to analyze MDOF systems, particularly multistory buildings, including finding maximum shear and bending moment in all members due to a dynamic load. The process entails computing approximate contribution factors to determine story displacements, which are then used to obtain nodal or lateral story dynamic forces that are necessary to perform a complete analysis of internal loading of the structural system.

The last part of the book, Chaps. 6 and 7, focuses on formulation and solution of the system of differential equations for MDOF systems. In Chap. 6 we focus on determining system vibration mode shapes and their associated natural periods, whereas Chap. 7 focuses primarily on a solution method known as modal analysis, which, along with the shock response spectra for general loading, can be used to establish the maximum structural response of building structures. With this maximum response, the maximum internal loads can be determined and used to design each member.

The book provides coverage of the essentials of structural dynamics, emphasizing the process of establishing and solving the equation of motion for various time-dependent loads. To that end, the reader is introduced to a wide variety of practical

dynamics loading examples and end-of-chapter problems. Also, to guide the reader, each chapter begins with a list of learning outcomes. After carefully studying this textbook, a reader should be able to:

1. Demonstrate a basic understanding of the various applications of structural dynamics.
2. Identify and solve basic structural dynamics problems.
3. Perform dynamic analyses of structural systems subjected to complex dynamic loadings.

The first objective relates to the student's ability to operate in the first two cognitive domains of Bloom's taxonomy (namely, knowledge of structural dynamics terms and comprehension of the various applications of structural dynamics). The second and third objectives primarily concentrate on the next two cognitive domains (namely, application of structural dynamics and analysis of systems subjected to various dynamic loadings). It is the hope of the authors that this along with the chapter learning objectives provides a roadmap to mastering the subject of structural dynamics.

Audience

The book is intended as a tool for a one-semester course in structural dynamics at the undergraduate or graduate levels, both in civil and architectural engineering. It provides students with an understanding of essential concepts and basic ideas relevant for solving many common and practical structural dynamics problems. Many solutions to example problems are prepared using computer programing methods (i.e., MATLAB) to enable students to solve the more complex dynamics problems. This book has also been written to support industry practitioners who are interested in gaining a working knowledge of structural dynamics and quickly gain insight into more complex analysis technics.

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We would enjoy receiving any comments or suggestions from students, instructors, and practitioners regarding the contents of this book.

Hector Estrada
Luke S. Lee