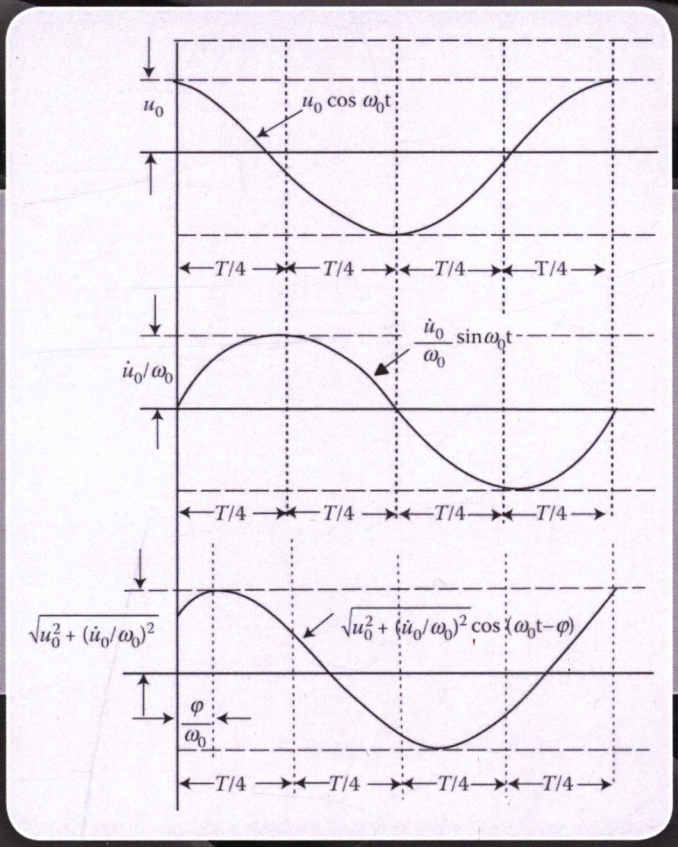
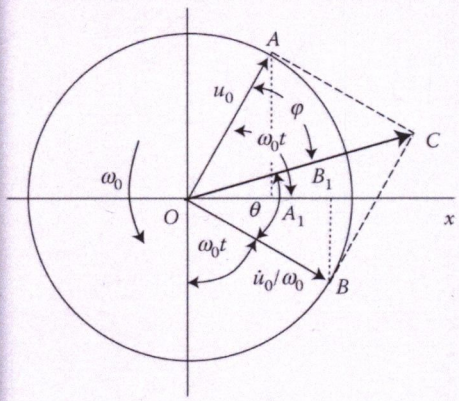
STRUCTURAL DYNAMICS

Concepts and Applications





Projection $OA_1 = u_0 \cos \omega_0 t$
Projection $OB_1 = [\dot{u}_0/\omega_0] \sin \omega_0 t$

Henry R. Busby
George H. Staab

CRC Press
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MECHANICAL ENGINEERING

STRUCTURAL DYNAMICS

Concepts and Applications

Structural Dynamics: Concepts and Applications focuses on dynamic problems in mechanical, civil and aerospace engineering through the equations of motion. The text explains structural response from dynamic loads and the modeling and calculation of dynamic responses in structural systems. A range of applications is included, from various engineering disciplines. Coverage progresses consistently from basic to advanced, with emphasis placed on analytical methods and numerical solution techniques. Stress analysis is discussed, and MATLAB® applications are integrated throughout. A solutions manual and figure slides for classroom projection are available for instructors.

Features

- Offers comprehensive coverage of structural dynamic fundamentals
- Includes computational methods and finite element analysis
- Provides in-depth coverage of single and multi-degree-of-freedom systems
- Analyzes frames, beams and shells in structural systems
- Includes MATLAB applications, and MATLAB files online

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Structural Dynamics

Henry R. Busby dedicates this book to his wife Nancy, daughters Corinne, Marlene, and grandchildren Anna, Thomas, Abigail, Samuel, and Prairie Rain.

George H. Staab dedicates this text to his wife Ellen, children Dan and Ben, daughter-in-law Jen, and granddaughter Claire.

Preface

The structural dynamics texts currently available present material in a variety of manners and at various technical levels. Some are intended for use by undergraduate students, others for graduate students, and some primarily address specific areas such as continuous systems or thin plates and shells. This text is intended for use by advanced undergraduate and beginning graduate students, and it includes material deemed most pertinent to the anticipated audience by presenting a variety of related topics for single- and multiple-degree-of-freedom systems. No previous knowledge of structural dynamics is required and all necessary background is assumed to come from required undergraduate engineering courses, making the text suitable for self-study. This text is intended to provide the knowledge necessary for establishing the equations of motion and determining the structural responses of systems resulting from dynamic loads. It is applicable to defining and understanding problems relevant to civil, mechanical, and aerospace engineering. Practicing engineers should have no problems using the material in this text as a reference.

In selecting topics for this text, emphasis was placed on the fundamentals of the subject, which include classical analytical methods and modern numerical solution techniques. It is structured so that students can learn the material in a clear forthright manner and develop a firm grasp of mathematical modeling, formulation, and solution of the equations of motion. The text presents an elementary introduction to time-dependent problems using the basic concepts of the single-degree-of-freedom spring–mass systems. Forced and free vibrations as well as damped and undamped systems are considered. Responses to general and arbitrary forcing functions are discussed along with material models (elastic, elastic–plastic, and viscoelastic) and integral transformations (Laplace, Fourier, Dirac, and Heaviside). Random vibrations and their related stochastic processes are presented in an early chapter so that these concepts can be used in subsequent chapters.

Two chapters are dedicated to numerical solution procedures, many of which are addressed using MATLAB® or similar commercially available programs. An early chapter is dedicated to single-degree-of-freedom systems in which finite difference techniques (Euler, Runge–Kutta, etc.), Newmark, Wilson-theta, and HHT-alpha methods are introduced. A later chapter is dedicated to multiple-degree-of-freedom systems, and the finite element method is introduced. Due to the abundance of finite element techniques available for different applications, only selected elements are presented. In addition to finite elements, the numerical techniques presented for one-dimensional problems are expanded upon.

Multiple-degree-of-freedom and continuous systems are presented in Chapters 4 and 5 with discussions of work and energy methods. The subsequent five chapters present topics relevant to specific structural members: strings and bars, beams (Euler–Bernoulli and Timoshenko), frames, plates (including composites), and shells. A brief discussion of continuous fiber-composite laminates is presented in Appendix A, and a relatively comprehensive list of additional references pertaining to structural dynamics is presented in Appendix B.

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Henry R. Busby earned an undergraduate degree in mechanical engineering at California State University, Long Beach, and his MS and PhD from the University of Southern California. Prior to his career in academia, Professor Busby had complied more than 15 years of experience in industry working at companies such as Rocketdyne, Canoga Park, California, TRW, Redondo Beach, California, Aerospace Corporation, El Segundo, California, PDA Engineering, Santa Ana, California, and Holmes & Narver, Inc., Orange, California.

He is currently emeritus faculty of mechanical and aerospace engineering at The Ohio State University, where he has taught machine design, computer-aided design, optimization, composite materials, and advanced strength of materials for the past 30 years. He is coauthor of three books, *Introductory Engineering Modeling Emphasizing Differential Models and Computer Simulations, Practical Inverse Analysis in Engineering,* and *Mechanical Design of Machine Elements and Machines.*

A life member of ASME, Professor Busby has authored or coauthored more than 35 papers in numerical methods and inverse problem as well as a consultant with government and various engineering firms.

George H. Staab is an emeritus faculty member in mechanical engineering and aerospace engineering at The Ohio State University. He earned BS and MS in aeronautical engineering from Purdue University in 1972 and 1973, respectively. He was employed as a rotor head and blade analyst by Sikorsky aircraft from 1973 to 1976, when he returned to Purdue in pursuit of his doctorate, which was earned in 1979. He then became an engineering mechanics faculty member at The Ohio State University. His 35-year teaching career ended in mechanical engineering and aerospace engineering. He was the faculty advisor for the FIRST Robotics and Formula SAE student project teams for many years. Additionally, he co-developed educational software accompanying Beer and Johnston's Statics, Dynamics, and Mechanics of Materials texts; is the sole author of *Laminar Composites*; and is the coauthor of *Mechanical Design of Machine Elements and Machines.*

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