Preface

Science is for those who learn;
poetry for those who know.
—*Joseph Roux*

This book is a continuation of my previous book, *Dynamics and Control of Structures* [44]. The expanded book includes three additional chapters and an additional appendix: Chapter 3, "Special Models"; Chapter 8, "Modal Actuators and Sensors"; and Chapter 9, "System Identification." Other chapters have been significantly revised and supplemented with new topics, including discrete-time models of structures, limited-time and -frequency grammians and reduction, almost-balanced modal models, simultaneous placement of sensors and actuators, and structural damage detection. The appendices have also been updated and expanded. Appendix A consists of thirteen new Matlab programs. Appendix B is a new addition and includes eleven Matlab programs that solve examples from each chapter. In Appendix C model data are given.

Several books on structural dynamics and control have been published. Meirovitch's textbook [108] covers methods of structural dynamics (virtual work, d'Alambert's principle, Hamilton's principle, Lagrange's and Hamilton's equations, and modal analysis of structures) and control (pole placement methods, LQG design, and modal control). Ewins's book [33] presents methods of modal testing of structures. Natke's book [111] on structural identification also contains excellent material on structural dynamics. Fuller, Elliot, and Nelson [40] cover problems of structural active control and structural acoustic control. Inman's book [79] introduces the basic concepts of vibration control, while Preumont in [120] presents modern approaches to structural control, including LQG controllers, sensors, and actuator placement, and piezoelectric materials with numerous applications in aerospace and civil engineering. The Junkins and Kim book [87] is a graduate-level textbook, while the Porter and Crossley book [119] is one of the first books on modal control. Skelton's work [125] (although on control of general linear systems) introduces methods designed specifically for the control of flexible structures. For example, the component cost approach to model or controller reduction is a tool frequently used in this field. The monograph by Joshi [83] presents developments on dissipative and LQG controllers supported by numerous applications. Genta's book [65] includes rotor dynamics; the book by Kwon and Bang [92] is dedicated mainly to structural finite-element models, but a part of it is dedicated to structural dynamics and control. The work by Hatch [70] explains vibrations and dynamics problems in practical ways, is illustrated with numerous examples, and supplies Matlab programs to solve vibration problems. The Maia and Silva book [107] is a study on modal analysis and testing, while the Heylen, Lammens, and Sas book [71] is an up-to-date and attractive presentation of modal analysis. The De Silva book [26] is a comprehensive source on vibration analysis and testing. Clark, Saunders, and Gibbs [17] present recent developments in dynamics and control of structures; and Elliott [31] applies structural dynamics and control problems to acoustics. My book [47] deals with structural dynamics and control problems in balanced coordinates. The recent advances in structural dynamics and control can be found in [121].

This book describes comparatively new areas of structural dynamics and control that emerged from recent developments. Thus:

- State-space models and modal methods are used in structural dynamics as well as in control analysis. Typically, structural dynamics problems are solved using second-order differential equations.
- Control system methods (such as the state-space approach, controllability and observability, system norms, Markov parameters, and grammians) are applied to solve structural dynamics problems (such as sensor and actuator placement, identification, or damage detection).
- Structural methods (such as modal models and modal independence) are used to solve control problems (e.g., the design of LQG and H_∞ controllers), providing new insight into well-known control laws.
- The methods described are based on practical applications. They originated from developing, testing, and applying techniques of structural dynamics, identification, and control to antennas and radiotelescopes. More on the dynamics and control problems of the NASA Deep Space Network antennas can be found at http://tmo.jpl.nasa.gov/tmo/progress_report/.
- This book uses approximate analysis, which is helpful in two ways. First, it simplifies analysis of large structural models (e.g., obtaining Hankel singular values for a structure with thousands of degrees of freedom). Second, approximate values (as opposed to exact ones) are given in closed form, giving an opportunity to conduct a parametric study of structural properties.

This book requires introductory knowledge of structural dynamics and of linear control; thus it is addressed to the more advanced student. It can be used in graduate courses on vibration and structural dynamics, and in control system courses with application to structural control. It is also useful for engineers who deal with structural dynamics and control.

Readers who would like to contact me with comments and questions are invited to do so. My e-mail address is Wodek.K.Gawronski@jpl.nasa.gov. Electronic versions of Matlab programs from Appendix A, examples from Appendix B, and data from Appendix C can also be obtained from this address.

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