STOCHASTIC DYNAMICS OF MARINE STRUCTURES

This book is meant to serve as a text for students and a reference for professionals on the basic theory and methods used for stochastic modeling and analysis of marine structures subjected to environmental loads. The first part of the book provides a detailed introduction to the basic dynamic analysis of structures, which serves as a foundation for later chapters on stochastic response analysis. This includes an extensive chapter on the finite element method. A careful introduction to stochastic modeling is provided, which includes the concepts of stochastic process, variance spectrum, random environmental processes, response spectrum, response statistics, and short- and long-term extreme value models. The second part of the book offers detailed discussions of limit state design approaches, fatigue design methods, equations of motion for dynamic structures, and numerical solution techniques. The final chapter highlights methods for prediction of extreme values from measured data or data obtained by Monte Carlo simulation.

Arvid Naess has been a professor of structural engineering since 1987 and a professor of mathematical statistics since 2001 at the Norwegian University of Science and Technology. He works on a wide range of problems related to stochastic dynamics of structures and structural safety and reliability. Professor Naess has published more than 250 scientific papers and lectured at conferences and universities worldwide. He is the associate editor of several international engineering journals. Professor Naess is a recipient of the Alfred M. Freudenthal Medal from ASCE and is an elected Fellow of the ASME and ASCE.

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Preface

This textbook provides the material for both basic and intermediate modern courses in dynamic analysis of ships and offshore structures. The word "modern" is used to signify that both deterministic and stochastic dynamics are covered. Because the main goal is to provide an introduction to dynamic analysis, the basic elements are described in some detail. A consequence of this is that the majority of the book deals with structures or structural elements that can be modeled or reduced to a single-degree-of-freedom (SDOF) system. However, realizing that multi-degree-of-freedom (MDOF) systems are unavoidable in many practical situations the engineer is likely to meet, and, consequently, that the basic principles for their analysis should be understood, a chapter on linear MDOF systems is included. This is also done to clearly demonstrate the principle of modal decomposition whereby an MDOF system is reduced to a set of uncoupled SDOF systems.

Broadly speaking, a dynamic analysis is carried out in two different ways according to how the loading is specified. If the time-variant loading is given in such a way that we may consider it to be exactly known as a function of time, the same will apply to the response. In such a case, the dynamic analysis is called deterministic. This is in contrast to a stochastic analysis, where the loading is specified using probabilistic concepts. This implies that the corresponding displacements and tensions can only be described in the same way. Even if naturally occurring loading to which a structure is subjected, such as wind and waves, can be claimed to be deterministic, its specification in terms of fundamental physical laws will remain beyond reach for any foreseeable length of time. For such types of loading, a stochastic description has proven to be exceedingly useful.

The first part of the book (Chapters 2–4) describes fundamental aspects of a deterministic dynamic analysis, with emphasis on simple but important dynamic problems relevant for marine structures. The second part (Chapters 5–16) provides a rather extensive introduction to stochastic dynamics of marine structures. Even though the book is focused on marine structures, with a suitable selection of material, it may also serve as a textbook for a more general course in the deterministic and stochastic dynamics of structures.

This book is supported by a Web site (www.cambridge.org/naess) containing numerous problems, many related to ships and offshore structures, that will make it useful not only for students, but also for professional engineers.

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Figures and illustrations are an important ingredient in a book like this. Most of these were done by Ole Erik Brandrud Naess and Gaute Halvorsen. Their expert assistance is much appreciated.

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