

Advances in Engineering 1

# Nonlinear Dynamics of Compliant Offshore Structures

Patrick Bar-Avi  
Haym Benaroya

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# Nonlinear Dynamics Of Compliant Offshore Structures

**Patrick Bar-Avi**



## **Nonlinear Dynamics Of Compliant Offshore Structures:**

**Nonlinear Dynamics of Compliant Offshore Structures** Patrick Bar-Avi, 2017-12-04 This monograph provides a general background to the modelling of a special class of offshore structures known as compliant structures External forcing is resisted by buoyancy and tension forces which increase when the structure is slightly offset from its equilibrium The technical development given in this book is presented in such a way as to highlight the adaptability of the modelling and the reader is shown how the techniques described can be applied to a variety of different offshore structures *Nonlinear*

*Dynamics of Compliant Offshore Structures* Patrick Bar-Avi, Haym Benaroya, 1997 This monograph provides a general background to the modelling of a special class of offshore structures known as compliant structures External forcing is resisted by buoyancy and tension forces which increase when the structure is slightly offset from its equilibrium The technical development given in this book is presented in such a way as to highlight the adaptability of the modelling and the reader is shown how the techniques described can be applied to a variety of different offshore structures *Nonlinear*  
*Dynamics of Compliant Offshore Structures* Patrick Bar-Avi, 2017-12-04 This monograph provides a general background to the modelling of a special class of offshore structures known as compliant structures External forcing is resisted by buoyancy and tension forces which increase when the structure is slightly offset from its equilibrium The technical development given in this book is presented in such a way as to highlight the adaptability of the modelling and the reader is shown how the techniques described can be applied to a variety of different offshore structures **Nonlinear and Stochastic Dynamics**

**of Compliant Offshore Structures** Seon Mi Han, Haym Benaroya, 2014-03-14 The purpose of this monograph is to show how a compliant offshore structure in an ocean environment can be modeled in two and three dimensions The monograph is divided into five parts Chapter 1 provides the engineering motivation for this work that is offshore structures These are very complex structures used for a variety of applications It is possible to use beam models to initially study their dynamics Chapter 2 is a review of variational methods and thus includes the topics principle of virtual work D'Alembert's principle Lagrange's equation Hamilton's principle and the extended Hamilton's principle These methods are used to derive the equations of motion throughout this monograph Chapter 3 is a review of existing transverse beam models They are the Euler Bernoulli Rayleigh shear and Timoshenko models The equations of motion are derived and solved analytically using the extended Hamilton's principle as outlined in Chapter 2 For engineering purposes the natural frequencies of the beam models are presented graphically as functions of normalized wave number and geometrical and physical parameters Beam models are useful as representations of complex structures In Chapter 4 a fluid force that is representative of those that act on offshore structures is formulated The environmental load due to ocean current and random waves is obtained using Morison's equation The random waves are formulated using the Pierson Moskowitz spectrum with the Airy linear wave theory

*Dynamics of Offshore Structures* James F. Wilson, 2003-01-03 Unique cutting edge material on structural dynamics and

natural forces for offshore structures Using the latest advances in theory and practice Dynamics of Offshore Structures Second Edition is extensively revised to cover all aspects of the physical forces structural modeling and mathematical methods necessary to effectively analyze the dynamic behavior of offshore structures Both closed form solutions and the Mathematica r software package are used in many of the up to date example problems to compute the deterministic and stochastic structural responses for such offshore structures as buoys moored ships and fixed bottom cable stayed and gravity type platforms Throughout the book consideration is given to the many assumptions involved in formulating a structural model and to the natural forces encountered in the offshore environment These analyses focus on plane motions of elastic structures with linear and nonlinear restraints as well as motions induced by the forces of currents winds earthquakes and waves including the latest theories and information on wave mechanics Topics addressed include multidegree of freedom linear structures continuous system analysis including the motion of cables and pipelines submerged pile design structural modal damping fluid structure soil interactions and single degree of freedom structural models that together with plane wave loading theories lead to deterministic or time history predictions of structural responses These analyses are extended to statistical descriptions of both wave loading and structural motion Dynamics of Offshore Structures Second Edition is a valuable text for students in civil and mechanical engineering programs and an indispensable resource for structural geotechnical and construction engineers working with offshore projects

**Dynamic Analysis and Design of Offshore Structures** Srinivasan Chandrasekaran, 2017-10-12 This book introduces readers to various types of offshore platform geometries It addresses the various environmental loads encountered by these structures and provides detailed descriptions of the fundamentals of structural dynamics in a classroom style helping readers estimate damping in offshore structures and grasp these aspects applications in preliminary analysis and design Basic concepts of structural dynamics are emphasized through simple illustrative examples and exercises Design methodologies and guidelines which are FORM based concepts are explained through a selection of applied sample structures Each chapter also features tutorials and exercises for self learning A dedicated chapter on stochastic dynamics helps students to extend the basic concepts of structural dynamics to this advanced domain of research Hydrodynamic response of offshore structures with perforated members is one of the most recent research applications and has proven to be one of the most effective means of retrofitting offshore structures In addition the book integrates the concepts of structural dynamics with the FORM evolved design of offshore structures offering a unique approach This new edition is divided into seven chapters each of which has been updated Each chapter also includes a section on frequently asked Questions and Answers Q A which enhances understanding of this complex subject through easy and self explanatory text Furthermore the book presents valuable content with respect to new and recent research carried out by the author in structural dynamics All numeric examples have been re checked with more additional explanations New exercises have been added to improve understanding of the subject matter Computer coding is also

included wherever possible to aid computer based learning of the contents of the book The book can serve as a textbook for senior undergraduate and graduate courses in civil structural applied mechanics mechanical aerospace naval architecture and ocean engineering programs The book can also serve as a text for professional learning and development programs or as a guide for practicing and consulting offshore structural engineers The contents of this book will be useful to graduate students researchers and professionals alike

Global Nonlinear Dynamics for Engineering Design and System Safety Stefano Lenci, Giuseppe Rega, 2018-09-24 This is the first book which exploits concepts and tools of global nonlinear dynamics for bridging the gap between theoretical and practical stability of systems structures and for possibly enhancing the engineering design in macro micro and nano mechanics Addressed topics include complementing theoretical and practical stability to achieve load carrying capacity dynamical integrity for analyzing global dynamics for interpreting predicting experimental behavior for getting hints towards engineering design techniques for control of chaos response of uncontrolled and controlled system models in applied mechanics and structural dynamics by also considering the effect of system imperfections from relatively simple systems to multidimensional models representative of real world applications potential and expected impact of global dynamics for engineering design

Stochastic Dynamics of Marine Structures Arvid Naess, Arvid Naess, Torgeir Moan, 2013 For students and professionals this covers theory and methods for stochastic modelling and analysis of marine structures under environmental loads

*Proceedings of the Fifth International Conference in Ocean Engineering (ICOE2019)* Vallam Sundar, S. A. Sannasiraj, V. Sriram, Manta Devi Nowbuth, 2020-11-08 This book comprises the proceedings of the Fifth International Conference in Ocean Engineering ICOE2019 focusing on emerging opportunities and challenges in the field of ocean engineering and offshore structures Some of the themes covered in this volume are offshore structures and deepwater technology ocean optics acoustics ocean renewable energy marine spatial planning climate change impacts disaster risk reduction etc The essays are written by leading international experts making it a valuable resource for researchers and practicing engineers alike

*Nonlinear Dynamics and Chaos* J. M. T. Thompson, H. B. Stewart, 2002-02-15 Nonlinear dynamics and chaos involves the study of apparent random happenings within a system or process The subject has wide applications within mathematics engineering physics and other physical sciences Since the bestselling first edition was published there has been a lot of new research conducted in the area of nonlinear dynamics and chaos Expands on the bestselling highly regarded first edition A new chapter which will cover the new research in the area since first edition Glossary of terms and a bibliography have been added All figures and illustrations will be modernised Comprehensive and systematic account of nonlinear dynamics and chaos still a fast growing area of applied mathematics Highly illustrated Excellent introductory text can be used for an advanced undergraduate graduate course text

*Dynamic Analysis of Non-Linear Structures by the Method of Statistical Quadraticization* M.G. Donley, Pol Spanos, 2012-12-06 1 1

Introduction As offshore oil production moves into deeper water compliant structural systems are becoming increasingly

important Examples of this type of structure are tension leg platforms TLP s guyed tower platforms compliant tower platforms and floating production systems The common feature of these systems which distinguishes them from conventional jacket platforms is that dynamic amplification is minimized by designing the surge and sway natural frequencies to be lower than the predominant frequencies of the wave spectrum Conventional jacket platforms on the other hand are designed to have high stiffness so that the natural frequencies are higher than the wave frequencies At deeper water depths however it becomes uneconomical to build a platform with high enough stiffness Thus the switch is made to the other side of the wave spectrum The low natural frequency of a compliant platform is achieved by designing systems which inherently have low stiffness Consequently the maximum horizontal excursions of these systems can be quite large The low natural frequency characteristic of compliant systems creates new analytical challenges for engineers This is because geometric stiffness and hydrodynamic force nonlinearities can cause significant resonance responses in the surge and sway modes even though the natural frequencies of these modes are outside the wave spectrum frequencies High frequency resonance responses in other modes such as the pitch mode of a TLP are also possible

**Stochastically Excited Nonlinear Ocean Structures** Michael F. Shlesinger, T. Swain, 1998 Ocean structures including ships boats piers docks rigs and platforms are subject to fair weather wind and waves as well as violent storms A scientific analysis of these structures under varying conditions requires a mix of civil engineering physics and applied mathematics Chapters by experts in these fields are presented which explore the nonlinear responses of ocean structures to stochastic forcing Theoretical methods calculate aspects of time frequency and phase space responses Probabilities governed by stochastic differential equations are investigated directly or through moment correlations such as power spectra Calculations can also involve level crossing statistics and first passage times Tiffs book will help scientists study stochastic nonlinear equations and help engineers design for short term survivability of structures in storms and long life in the face of everyday fatigue

**Nondeterministic Mechanics** Isaac Elishakoff, Christian Soize, 2013-07-30 Table of contents Stochastic methods in nonlinear structural dynamics Stochastic models of uncertainties in computational structural dynamics and structural acoustics The tale of stochastic linearization techniques over half a century of progress Comprehensive modeling of uncertain systems using fuzzy set theory Bounding uncertainty in civil engineering theoretical background and applications Combined methods in nondeterministic mechanics In this book the current state of the art of nondeterministic mechanics in its various forms is presented The topics range from stochastic problems to fuzzy sets from linear to nonlinear problems from specific methodologies to combinations of various techniques from theoretical considerations to practical applications It is specially designed to illuminate the various aspects of the three methodologies probabilistic or stochastic modelling fuzzy sets based analysis antioptimization of structures to deal with various uncertainties and deepen the discussion of their pros and cons

**The Shock and Vibration Digest** ,1993

*Proceedings of the Fourth International Conference in Ocean Engineering (ICOE2018)* K. Murali, V. Sriram, Abdus

Samad, Nilanjan Saha, 2018-12-31 This book comprises selected proceedings of the Fourth International Conference in Ocean Engineering ICOE2018 focusing on emerging opportunities and challenges in the field of ocean engineering and offshore structures. It includes state of the art content from leading international experts making it a valuable resource for researchers and practicing engineers alike.

**IUTAM Symposium on Integrated Modeling of Fully Coupled Fluid Structure Interactions Using Analysis, Computations and Experiments** Haym Benaroya, Timothy Wei, 2012-12-06 This plenary paper and the accompanying presentation have highlighted field problems involving fluid structure interaction over a wide span of Navy operations. Considering the vast size and versatility of the Navy's inventory, the cases presented represent examples of a much larger problem. But even this limited set provides sufficient evidence that fluid structure interaction does hinder the Navy's ability to accomplish its missions. This survey has also established that there are no accurate and generally applicable design tools for addressing these problems. In the majority of cases, the state of practice is to either make ad hoc adjustments and estimates based on historical evidence or conduct expensive focused tests directed at each specific problem and/or candidate solution. Unfortunately, these approaches do not provide insight into the fundamental problem and neither can be considered reliable regarding their likelihood of success. So the opportunities for applying computational fluid structure interaction modeling to Navy problems appear limitless. Scenarios range from the simple resonant strumming of underwater and in-air cables to the self-contained flow field and vibration of aircraft ordnance bodies at various Mach numbers to violent underwater transient detonations and local hull structural collapse. Generally applicable and computationally tractable design-oriented models for these phenomena are of course still far in the future. But the Navy has taken the first steps in that direction by sponsoring specialized numerical models validation experiments tailored for specific applications and conferences such as this one.

**Symbolic Modeling of Multibody Systems** J-C. Samin, P. Fisette, 2003-11-30 Modeling and analysing multibody systems require a comprehensive understanding of the kinematics and dynamics of rigid bodies. In this volume, the relevant fundamental principles are first reviewed in detail and illustrated in conformity with the multibody formalisms that follow. Whatever the kind of system tree-like structures, closed loop mechanisms, systems containing flexible beams or involving tire-ground contact, wheel-rail contact etc., these multibody formalisms have a common feature in the proposed approach: viz. the symbolic generation of most of the ingredients needed to set up the model. The symbolic approach, chosen specially dedicated to multibody systems, affords various advantages: it leads to a simplification of the theoretical formulation of models, a considerable reduction in the size of generated equations and hence in resulting computing time, and also enhanced portability of the multibody models towards other specific environments. Moreover, the generation of multibody models as symbolic toolboxes proves to be an excellent pedagogical medium in teaching mechanics.

*Nonlinear Dynamics and Stochastic Mechanics* Wei-Chau Xie, Navaratnam Sri Namachchivaya, Balakumar Balachandran, 2000 Thirteen papers from a November 2000 meeting examine central topics in

theory and applications of nonlinear dynamics stochastic mechanics and dynamics and control of nonlinear mechanical and structural systems Papers address topics related to fundamental applied analytical computational and e      *Ship Motion Control* Tristan Perez,2006-03-30 engineers into a single volume whilst concentrating on two important research control design problems autopilots with rudder roll stabilization and fin and combined rudder fin stabilization He has been guided by some of the leading marine control academics in particular Mogens Blanke and Thor Fossen indeed Chapters 3 and 4 on kinematics and kinetics of ship motion are jointly authored with Professor Fossen There are some 240 cited references an invaluable resource for interested readers The volume is likely to appeal to a wide range of readers who will each be able to extract something different from the various parts of the monograph Part I has some four chapters on the modelling fundamentals including kinematics dynamics and actuators Part II is a very useful survey of the ship roll stabilization problem and how ship roll performance is measured and assessed This clearly motivates the human necessity for roll reduction and roll stabilization Parts III and IV move on to the control systems aspects of the various stabilization designs Valuable material here includes a study of system performance limitations as caused by the presence of non minimum phase characteristics and actuator saturation Chapter 10 has an interesting historical review of these marine control problems stretching back some thirty years into the 1970s      *Random Vibration and Statistical Linearization* John Brian Roberts,Pol D. Spanos,2003-12-09 This self contained volume explains the general method of statistical linearization and its use in solving random vibration problems Numerous examples show advanced undergraduate and graduate students many practical applications 1990 edition



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