

# DYNAMICS OF OFFSHORE STRUCTURES

SECOND EDITION



JAMES F. WILSON

# Dynamics Of Offshore Structures

**Patrick Bar-Avi**



## **Dynamics Of Offshore Structures:**

Dynamics of Offshore Structures Minoo H Patel, 2013-10-22 Dynamics of Offshore Structures provides an integrated treatment of the main subject areas that contribute to the design construction installation and operation of fixed and floating offshore structures The book begins with an overview of offshore oil and gas development and offshore structures Separate chapters follow on the ocean environment basic fluid mechanics gravity wave theories fluid loading on offshore structures hydrostatics and dynamic response of floating bodies and model testing of offshore structures This book is prepared with particular emphasis on the fundamentals of oceanography basic fluid mechanics wave theory hydrodynamics naval architecture and structural analysis to meet the needs of students reading ocean engineering or naval architecture at both undergraduate and postgraduate levels Basic equations and theoretical results are derived in a rigorous manner but sections on model testing full scale measurements design and certification are also included to ensure that the book is of value to professional engineers seeking a balanced treatment of fundamental and practical issues

**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

**Dynamics of Floating Offshore Structures** Subrata K Chakrabarti, 2010-07 This book will provide a complete coverage on the dynamics of floating offshore structures Topics like random waves wind and current etc will be developed from the fundamental principles and their applications to offshore structures will be discussed The design aspect of the offshore structure both for short term and long term response and structural fatigue are

important elements of the dynamic response and will be further elaborated upon in the text *Dynamics of Floating Offshore Structures* is designed to be used both as a textbook for graduate courses and as a reference work in offshore and ocean engineering Its uniqueness lies in its treatment of theoretical and practical aspects of offshore structure dynamics and will stand out from the other available publications on this general subject

**Dynamics of Offshore Structures** Minoo H. Patel, 1989

*Hydrodynamics of Offshore Structures* Subrata Kumar Chakrabarti, 1987 The subject of hydrodynamics applied to offshore structures is vast The topics covered in this book aim to help the reader understand basic principles while at the same time giving the designer enough information for particular designs Thus results are given with derivations and applications are discussed with the aid of examples with an overview of the advantages and limitations of the method involved This makes the book suitable as a text for undergraduate and graduate students specializing in offshore and ocean engineering

**Rigid Finite Element Method in Analysis of Dynamics of Offshore Structures** Edmund Wittbrodt, Marek Szczotka, Andrzej Maczyński, Stanisław Wojciech, 2012-08-09 This book describes new methods developed for modelling dynamics of machines commonly used in the offshore industry These methods are based both on the rigid finite element method used for the description of link deformations and on homogeneous transformations and joint coordinates which is applied to the modelling of multibody system dynamics In this monograph the bases of the rigid finite element method and homogeneous transformations are introduced Selected models for modelling dynamics of offshore devices are then verified both by using commercial software based on the finite element method as well as by using additional methods Examples of mathematical models of offshore machines such as a gantry crane for Blowout Preventer BOP valve block transportation a pedestal crane with shock absorber and pipe laying machinery are presented Selected problems of control in offshore machinery as well as dynamic optimization in device control are also discussed Additionally numerical simulations of pipe laying operations taking active reel drive into account are shown

**Dynamics of Floating Offshore Structures** Subrata K. Chakrabarti, 2012-08-01 This book will provide a complete coverage on the dynamics of floating offshore structures Topics like random waves wind and current etc will be developed from the fundamental principles and their applications to offshore structures will be discussed The design aspect of the offshore structure both for short term and long term response and structural fatigue are important elements of the dynamic response and will be further elaborated upon in the text *Dynamics of Floating Offshore Structures* is designed to be used both as a textbook for graduate courses and as a reference work in offshore and ocean engineering Its uniqueness lies in its treatment of theoretical and practical aspects of offshore structure dynamics and will stand out from the other available publications on this general subject

**Offshore Mechanics** Madjid Karimirad, Constantine Michailides, Ali Nematbakhsh, 2018-01-30 Covers theoretical concepts in offshore mechanics with consideration to new applications including offshore wind farms ocean energy devices aquaculture floating bridges and submerged tunnels This comprehensive book covers important aspects of the required analysis and design of

offshore structures and systems and the fundamental background material for offshore engineering Whereas most of the books currently available in the field use traditional oil gas and ship industry examples in order to explain the fundamentals in offshore mechanics this book uses more recent applications including recent fixed bottom and floating offshore platforms ocean energy structures and systems such as wind turbines wave energy converters tidal turbines and hybrid marine platforms Offshore Mechanics covers traditional and more recent methodologies used in offshore structure modelling including SPH and hydroelasticity models It also examines numerical techniques including computational fluid dynamics and finite element method Additionally the book features easy to understand exercises and examples Provides a comprehensive treatment for the case of recent applications in offshore mechanics for researchers and engineers Presents the subject of computational fluid dynamics CFD and finite element methods FEM along with the high fidelity numerical analysis of recent applications in offshore mechanics Offers insight into the philosophy and power of numerical simulations and an understanding of the mathematical nature of the fluid and structural dynamics with focus on offshore mechanic applications Offshore Mechanics Structural and Fluid Dynamics for Recent Applications is an important book for graduate and senior undergraduate students in offshore engineering and for offshore engineers and researchers in the offshore industry

**Dynamic Analysis and Design of Offshore Structures** Srinivasan Chandrasekaran, 2015 This book attempts to provide readers with an overall idea of various types of offshore platform geometries It covers the various environmental loads encountered by these structures a detailed description of the fundamentals of structural dynamics in a class room style estimate of damping in offshore structures and their applications in the 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 few applied example structures Each chapter also has tutorials and exercises for self learning A dedicated chapter on stochastic dynamics will help the 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 recent research applications which is found to be one of the effective manner of retrofitting offshore structures Results of recent research validated by the experimental and numerical studies are presented to update the readers Integration of the concepts of structural dynamics with the FORM evolved design of offshore structures is a unique approach used in this book The book will prove useful to the practicing and consulting offshore structural engineers as also to students and researchers working in the field

*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      **Dynamic Analysis of Offshore Structures** C.A. Brebbia, S. Walker, 2013-10-22 Dynamic Analysis of Offshore Structures appraises offshore structures particularly the major sources of uncertainty in the design process The book explains the fundamentals of probabilistic processes the theory or analysis of sea states and the random vibration approach to structural response The text describes the hydrodynamics of water waves wave forecasting and the statistical parameters associated with sea states The investigator can use Morison's equation to calculate the impact of wave forces acting on slender members such as on lattice type structures Or he can employ the diffraction theory to calculate wave forces acting on large diameter bodies such as concrete gravity type structures Other environmental forces he should be concerned with are the effects of currents and winds The book examines the theory of vibration including the spectral approach the theory of vibration on multi degree of freedom structures matrix analysis of structural response problems of fatigue and soil structure interaction The book notes the importance of the method of analysis used with emphasis on the following dynamic analysis frequency domain and linearization of drag Two types of analysis follow linearization of drag deterministic analysis applied in a series of design waves which uses the long term exceedance diagram for fatigue or probabilistic analysis used to study the behavior of the structure during the extreme design storm and its long term behavior for a range of sea states The book can prove useful for structural civil or maritime engineers as well as for students in one year courses in offshore structure analysis at the postgraduate or final year undergraduate level      **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, Part I R. Eatock Taylor, A. Rajagopalan, 1982 First of 2 companion papers concerned with assessment of non linear effects implied by modified Morison equation Describes

approach for interpreting dynamic response of offshore towers which are excited by Morison type wave loading This paper adopts spectral approach      **Ocean Wave Dynamics For Coastal And Marine Structures** Vallam Sundar,2021-07-05 The increase in exploration and exploitation of ocean resources maritime trade and ocean energy have led to development of new concepts in the study of coastal and marine structures These developments necessitate comprehensive and in depth knowledge of ocean wave behavior in the offshore as well as in the nearshore such as the phenomena of wave generation propagation deformation and its effects which help to enlighten our understanding of its influence on coastal and offshore structures Ocean Wave Dynamics for Coastal and Marine Structures is a recommended textbook for students and researchers in ocean sciences engineering and related topics It offers application of theoretical formulae to practical relevance through problem solving This book will also be invaluable for professionals in ports offshore and marine industries as well as consulting companies      Essentials of Offshore Structures D.V. Reddy,A. S. J. Swamidas,2016-04-19 Essentials of Offshore Structures Framed and Gravity Platforms examines the engineering ideas and offshore drilling platforms for exploration and production This book offers a clear and acceptable demonstration of both the theory and application of the relevant procedures of structural fluid and geotechnical mechanics to offshore structures It      **Dynamics of Fixed Marine Structures** N. D. P. Barltrop,A. J. Adams,2013-10-22 Dynamics of Fixed Marine Structures Third Edition proves guidance on the dynamic design of fixed structures subject to wave and current action The text is an update of the UR8 design guide Dynamics of Marine Structures with discussion of foundations wind turbulence offshore installations earthquakes and strength and fatigue The book employs analytical methods of static and dynamic structural analysis techniques particularly the statistical and spectral methods when applied to loading and in the calculating dynamic responses The statistical methods are explained when used to wave wind and earthquake calculations together with the problems encountered in actual applications Of importance to fixed offshore platforms are the soil properties and foundation covering soil behavior site investigation testing seabed stability gravity structures and the use of single piles Methods of forecasting measuring and modeling of waves and currents are also presented in offshore structure construction Basic hydrodynamics is explained in understanding wave theory and some description is given to forecasting of environmental conditions that will affect the structures The effects of vortex induced vibrations on the structure are explained and the three methods that can prevent vortex induced oscillations are given Wind turbulence or wind loads are analyzed against short natural period or long natural periods of structures The transportation of offshore platforms installation and pile driving including examples of the applications found in the book are given as well The guide is helpful for offshore engineers designers of inshore jetties clients needing design and analysis work specialists related to offshore structural engineering and students in offshore engineering      *Nonlinear Dynamics of Compliant Offshore Structures* Patrick Bar-Avi,Haym Benaroya,2017 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 Provided by publisher

**Wave Dynamics and Offshore Structures** Indian Institute of Technology, Bombay. Department of Civil Engineering, Indian Society for Technical Education, 1977\*

**The Theory And Practice Of Hydrodynamics And Vibration** Subrata Kumar Chakrabarti, 2002-11-05 This book covers the basics of the hydrodynamics and vibration of structures subjected to environmental loads It describes the interaction of hydrodynamics with the associated vibration of structures giving simple explanations Emphasis is placed on the applications of the theory to practical problems Several case studies are provided to show how the theory outlined in the book is applied in the design of structures Background material needed for understanding fluid induced vibrations of structures is given to make the book reasonably self sufficient Examples are taken mainly from the novel structures that are of interest today including ocean and offshore structures and components Besides being a text for undergraduates this book can serve as a handy reference for design engineers and consultants involved in the design of structures subjected to dynamics and vibration

**Uncertainty Quantification in the Dynamic Analysis of Offshore Structures** HyeonGuk Lim, 2019 Consideration for uncertainty is critical in problems associated with structural dynamics especially in the offshore environment Deterministic solutions are often insufficient to achieve confidence in computational results and for use in design In uncertainty quantification UQ for problems dealing with many random or stochastic sources surrogate models are often developed to reduce costs associated with running a truth model to verify response levels associated with low probability Polynomial chaos expansion PCE is one approach used in developing such surrogate models However conventional PCE relies on parametric families to define the polynomials for expansion Also for high dimensional problems PCE can be inefficient if appropriate dimension reduction is not employed Arbitrary PCE aPCE approaches based on Gram Schmidt orthogonalization can be used to define polynomials in terms of the uncertain variables and offers a non parametric option for UQ An aPCE approach that can systematically account for multivariate stochasticity is developed in this study Dimension reduction can aid in developing computationally efficient surrogate models in this study a gradient based active subspace approach that identifies dominant influences on a model output s variability is employed for dimension reduction Both aPCE and active subspace dimension reduction are employed in studies that are focused on the dynamics of offshore structures and on low probability events of interest This dissertation represents a collection of four papers that deal with PCE surrogate modeling and dimension reduction Each paper representing a separate chapter contributes to the development of accurate and efficient UQ approaches for offshore structure dynamics problems involving various sources of uncertainty We demonstrate the proposed approaches in different applications I estimation of fatigue damage in a marine riser due to vortex induced vibration II prediction of the long term extreme response of a moored



floating structure III surrogate model development for structural reliability analysis and IV dimension reduction in the extreme response prediction of offshore structures

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