Linear Water Waves A Mathematical Approach

The contributions in this volume are dedicated to Vladimir G. Maz'ya and are par tially based on talks given at the conference "Functional Analysis, Partial Differ ential Equations, and Applications", which took place at the University of Rostock from August 31 to September 4, 1998, to honour Prof. Maz'ya. This conference (a satellite meeting of the ICM) gave an opportunity to many friends and colleagues from all over the world to honour him. This academic community is very large. The scientific field of Prof. Maz'ya is impressively broad, which is reflected in the variety of contributions included in the volumes. Vladimir Maz'ya is the author and co-author of many publications (see the list of publications at the end of this volume), the topics of which extend from functional analysis, function theory and numerical analysis to partial differential equations and their broad applications. Vladimir G. Maz'ya provided significant contributions, among others to the the ory of Sobolev spaces, the capacity theory, boundary integral methods, qualitative and asymptotic methods of analysis of linear and nonlinear elliptic differential equations, the Cauchy problem for elliptic and hyperbolic equations, the theory of multipliers in spaces of differentiable functions, maximum principles for elliptic and parabolic systems, and boundary value problems in domains with piecewise smooth boundaries. Surveys on Maz'ya's work in different fields of mathematics and areas, where he made essential contributions, form a major part of

the present first volume of The Maz'ya Anniversary Collection.
This text considers classical and modern problems in linear and non-linear water-wave theory.
This volume brings together four lecture courses on modern aspects of water waves. The intention, through the lectures, is to present quite a range of mathematical ideas, primarily to show what is possible and what, currently, is of particular interest. Water waves of large amplitude can only be fully understood in terms of nonlinear effects, linear theory being not adequate for their description. Taking advantage of insights from physical observation, experimental evidence and numerical simulations, classical and modern mathematical approaches can be used to gain insight into their dynamics. The book presents several avenues and offers a wide range of material of current interest. The lectures provide a useful source for those who want to begin to investigate how mathematics can be used to improve our understanding of water wave phenomena. In addition, some of the material can be used by those who are already familiar with one branch of the study of water waves, to learn more about other areas.
This unique book aims to treat a class of nonlinear waves that are reflected from the boundaries of media of finite extent. It involves both standing (unforced) waves and resonant oscillations due to external periodic forcing. The waves are both hyperbolic and dispersive. To achieve this aim, the book develops the necessary understanding of linear waves and the mathematical techniques of nonlinear waves before dealing with

nonlinear waves in bounded media. The examples used come mainly from gas dynamics, water waves and viscoelastic waves.

The Maz’ya Anniversary Collection

The Maz'ya Anniversary Collection

Handbook of Mathematical Techniques for Wave/Structure Interactions

Linear and Nonlinear Waves

Journal of Nonlinear Mathematical Physics Vol. 14

Excerpt from Water Waves: The Mathematical Theory With Applications The subject of surface gravity waves has great variety whether regarded from the point of View of the types of physical problem which occur, or from the point of View of the mathematical ideas and methods needed to attack them. The physical problems range from discussion of wave motion over sloping beaches to flood waves in rivers, the motion of ships in a sea-way, free oscillations of enclosed bodies of water such as lakes and harbors, and the propagation of frontal discontinuities in the atmosphere, to mention just a few. The mathematical tools employed comprise just about the whole of the tools developed in the classical linear mathematical physics concerned with partial differential equations, as well as a good part of what has been learned about the nonlinear problems of mathe matical physics. Thus potential theory and the theory of the linear wave equation, together with such tools as conformal mapping and complex variable methods in general, the Laplace and Fourier transform techniques, methods employing a Green's function, integral equations, etc. Are used. The nonlinear problems are of both elliptic and hyperbolic *type. In spite of the diversity of the material, the book, is not a collection of disconnected topics, written for specialists, and lacking unity and coherence. Instead, considerable pains have been taken to supply the fundamental background in hydrodynamics and also in some of the mathematics needed and to plan the book in order that it should be as much as possible a self - contained and readable whole. Though the contents of the book are outlined in detail below, it has some point to indicate briefly here its general plan. There are four main parts of the book. About the Publisher Forgotten Books publishes hundreds of thousands of rare and classic books. Find more at www.forgottenbooks.com This book is a reproduction of an important historical work. Forgotten Books uses state-of-the-art technology to digitally reconstruct the work, preserving the original format whilst repairing imperfections present in the aged copy. In rare cases, an imperfection in the original, such as a blemish or missing page, may be replicated in our edition. We do, however, repair the vast majority of imperfections successfully; any imperfections that remain are intentionally left to preserve the state of such historical works.*

The mathematical techniques used to handle various water wave problems are varied and fascinating. This book highlights a number of these techniques in connection with investigations of some classes of water wave problems by leading researchers in this field. The first eight chapters discuss linearised theory while the last two cover nonlinear analysis. This book will be an invaluable source of reference for advanced mathematical work in water wave theory.

This is the first volume of a collection of articles dedicated to V.G Maz'ya on the occasion of his 60th birthday. It contains surveys on his work in different fields of mathematics or on areas to *which he made essential contributions. Other articles of this book have their origin in the common work with Maz'ya. V.G Maz'ya is author or co-author of more than 300 scientific works on various fields of functional analysis, function theory, numerical analysis, partial differential equations and their application. The reviews in this book show his enormous productivity and the large variety of his work. The scond volume contains most of the invited lectures of the Conference on Functional Analysis, Partial Differential Equations and Applications held in Rostock in September 1998 in honor of V.G Maz'ya. Here different problems of functional analysis, potential theory, linear and nonlinear partial differential equations, theory of function spaces and numerical analysis are treated. The authors, who are outstanding experts in these fields, present surveys as well as new results.*

This comprehensive text describes the science of waves in fluids.

Linear Water Waves

The Mathematical Theory with Applications

Water Waves and Ship Hydrodynamics

Wave Motion

Mathematical Analysis and Asymptotics

The theory of water waves is most varied and is a fascinating topic. It includes a wide range of natural phenomena in oceans, rivers, and lakes. It is mostly concerned with elucidation of some general aspects of wave motion including the prediction of behaviour of waves in the presence of

obstacles of some special configurations that are of interest to ocean engineers. Unfortunately, even the apparently simple problems appear to be difficult to tackle mathematically unless some simplified assumptions are made. Fortunately, one can assume water to be an incompressible, in viscid and homogeneous fluid. The linearised theory of water waves is based on the assumption that the amplitude of the motion is small compared to the wave length. If rotational motion is assumed, then the linearised theory of water waves is essentially concerned with solving the Laplace equation in the water region together with linearised boundary condition. There are varied classes of problems that have been/are being studied mathematically in the literature within the framework of linearised theory of water waves for last many years. Scattering by obstacles of various geometrical configurations is one such class of water wave problems. This book is devoted to advanced mathematical work related to water wave scattering. Emphasis is laid on the mathematical and computational techniques required to study these problems mathematically. The book contains nine chapters. The first chapter is introductory in nature. It includes the basic equations of linearised theory for a single layer fluid, a two-layer fluid, solution of dispersion equations, and a general idea on scattering problems and the energy identity in water with a free surface. Chapter 2 is concerned

with wave scattering involving thin rigid plates of various geometrical configurations, namely, plane vertical barriers or curved barriers, inclined barriers, horizontal barrier, and also thin elastic vertical plate. For the horizontal case, the barrier is submerged below an ice-cover modelled as a thin elastic plate floating on water. Chapter 3 discusses wave scattering by a rectangular trench by using Galerkin technique. Chapter 4 involves wave scattering by a dock by using Carleman singular integral equation followed by reduction to Riemann-Hilbert problems. Chapter 5 involves several wave scattering problems involving discontinuities at the upper surface of water by using the Wiener-Hopf technique, by reduction to Carleman singular integral equations. Chapter 6 considers scattering by a long horizontal circular cylinder either half immersed or completely submerged. In chapter 7, some important energy identities are derived for scattering problems in a single-layer and also in a two-layer fluid. Chapter 8 is concerned with wave scattering in a two-layer fluid by a thin vertical plate and by a long horizontal circular cylinder submerged in either of the two layers. Chapter 9 is the final chapter which considers a number of wave scattering problems in a single-layer or a two-layer fluid with variable bottom topography by using a simplified perturbation analysis It is hoped that this book will be useful to researchers on water waves. The several wave scattering problems

presented in the book are mostly based on the research work carried out by the authors and their associates.

This memoir is devoted to the proof of a well-posedness result for the gravity water waves equations, in arbitrary dimension and in fluid domains with general bottoms, when the initial velocity field is not necessarily Lipschitz. Moreover, for two-dimensional waves, the authors consider solutions such that the curvature of the initial free surface does not belong to L2. The proof is entirely based on the Eulerian formulation of the water waves equations, using microlocal analysis to obtain sharp Sobolev and Hölder estimates. The authors first prove tame estimates in Sobolev spaces depending linearly on Hölder norms and then use the dispersive properties of the water-waves system, namely Strichartz estimates, to control these Hölder norms.

This 2002 book examines the interaction between ocean waves and oscillating systems. With a focus on linear analysis of low-amplitude waves, the text is designed to convey a thorough understanding of wave interactions. Topics covered include the background mathematics of oscillations, gravity waves on water, the dynamics of wave-body interactions, and the absorption of wave energy by oscillating bodies. Linear algebra, complex numbers, differential equations, and Fourier transformation are

utilized as bases for the analysis, and each chapter ends with problems. While the book's focus is on linear theory, the practical application of energy storage and transport is interwoven throughout. This book will be appropriate for those with backgrounds in elementary fluid dynamics or hydrodynamics and mathematical analysis. Graduate students and researchers will find it an excellent source of wave energy theory and application.

In the summer of 2014 leading experts in the theory of water waves gathered at the Newton Institute for Mathematical Sciences in Cambridge for four weeks of research interaction. A cross-section of those experts was invited to give introductory-level talks on active topics. This book is a compilation of those talks and illustrates the diversity, intensity, and progress of current research in this area. The key themes that emerge are numerical methods for analysis, stability and simulation of water waves, transform methods, rigorous analysis of model equations, three-dimensionality of water waves, variational principles, shallow water hydrodynamics, the role of deterministic and random bottom topography, and modulation equations. This book is an ideal introduction for PhD students and researchers looking for a research project. It may also be used as a supplementary text for advanced courses in mathematics or fluid

dynamics.

Proceedings of the St. Petersburg Mathematical Society

Introduction to Water Waves

Relating Modern Theory to Advanced Engineering Applications

Wave Diffraction and Refraction

The Mathematical Theory with Applications (Classic Reprint)

Although a wide range of mathematical techniques can apply to solving problems involving the interaction of waves with structures, few texts discuss those techniques within that context-most often they are presented without reference to any applications. Handbook of Mathematical Techniques for Wave/Structure Interactions brings together some of the most important techniques useful to applied mathematicians and engineers. Each chapter is dedicated to a particular technique, such as eigenfunction expansions, multipoles, integral equations, and Wiener-Hopf methods. Other chapters discuss approximation techniques and variational methods. The authors describe all of the techniques in terms of wave/structure interactions, with most illustrated by application to research problems. They provide detailed explanations of the important steps within the mathematical development, and, where possible, physical interpretations of mathematical results. Handbook of Mathematical Techniques for Wave/Structure Interactions effectively bridges the gap between the heavy computational methods preferred by some engineers and the more mathematical approach favored by others. These techniques provide a powerful means of dealing with wave/structure interactions, are readily applied to relevant problems, and illuminate those problems in a way that neither a purely computational approach nor a straight theoretical treatment can.

This volume contains articles on analysis, theory of algebraic groups, partial differential equations, pseudodifferential operators, wavelets, and other areas of mathematics. This book is suitable for a broad group of graduate students and researchers interested in the topics presented here.

Offers an integrated account of the mathematical hypothesis of wave motion in liquids with a free surface, subjected to gravitational and other forces. Uses both potential and linear wave equation theories, together with applications such as the Laplace and Fourier transform methods, conformal mapping and complex variable techniques in general or integral equations, methods employing a Green's function. Coverage includes fundamental hydrodynamics, waves on sloping beaches, problems involving waves in shallow water, the motion of ships and much more.

Waves are a ubiquitous and important feature of the physical world, and throughout history it has been a major challenge to understand them. They can propagate on the surfaces of solids and of fluids; chemical waves control the beating of your heart; traffic jams move in waves down lanes crowded with vehicles. This introduction to the mathematics of wave phenomena is aimed at advanced undergraduate courses on waves for mathematicians, physicists or engineers. Some more advanced material on both linear and nonlinear waves is also included, thus making the book suitable for beginning graduate courses. The authors assume some familiarity with partial differential equations, integral transforms and asymptotic expansions as well as an acquaintance with fluid mechanics, elasticity and electromagnetism. The context and physics that underlie the mathematics is clearly explained at the beginning of each chapter. Worked examples and exercises are supplied throughout, with solutions available to teachers.

Theoretical Fluid Dynamics

Mathematical and Numerical Aspects of Wave Propagation WAVES 2003

Water Wave Scattering

Volume 1: On Maz'ya's work in functional analysis, partial differential equations and applications

Water Waves

This book gives a self-contained and up-to-date account of mathematical results in the linear theory of water waves. The study of waves has many applications, including the prediction of behavior of floating bodies (ships, submarines, tension-leg platforms etc.),

the calculation of wave-making resistance in naval architecture, and the description of wave patterns over bottom topography in geophysical hydrodynamics. The first section deals with time-harmonic waves. Three linear boundary value problems serve as the approximate mathematical models for these types of water waves. The next section uses a plethora of mathematical techniques in the investigation of these three problems. The techniques used in the book include integral equations based on Green's functions, various inequalities between the kinetic and potential energy and integral identities which are indispensable for proving the uniqueness theorems. The so-called inverse procedure is applied to constructing examples of non-uniqueness, usually referred to as 'trapped nodes.'
First published in 1957, this is a classic monograph in the area of applied mathematics. It offers a connected account of the mathematical theory of wave motion in a liquid with a free surface and subjected to gravitational and other forces, together with applications to a wide variety of concrete physical problems. A never-surpassed text, it remains of permanent value to a wide range of scientists and engineers concerned with problems in fluid mechanics. The four-part treatment begins with a presentation of the derivation of the basic hydrodynamic theory for non-viscous incompressible fluids and a description of the two principal approximate theories

that form the basis for the rest of the book. The second section centers on the approximate theory that results from small-amplitude wave motions. A consideration of problems involving waves in shallow water follows, and the text concludes with a selection of problems solved in terms of the exact theory. Despite the diversity of its topics, this text offers a unified, readable, and largely self-contained treatment.

This textbook gives an introduction to fluid dynamics based on flows for which analytical solutions exist, like individual vortices, vortex streets, vortex sheets, accretions disks, wakes, jets, cavities, shallow water waves, bores, tides, linear and non-linear free-surface waves, capillary waves, internal gravity waves and shocks. Advanced mathematical techniques ("calculus") are introduced and applied to obtain these solutions, mostly from complex function theory (Schwarz-Christoffel theorem and Wiener-Hopf technique), exterior calculus, singularity theory, asymptotic analysis, the theory of linear and nonlinear integral equations and the theory of characteristics. Many of the derivations, so far contained only in research journals, are made available here to a wider public.

This is the first book on explosion-generated water waves. It presents the theoretical foundations and experimental results of the generation and propagation of impulsively generated waves resulting from underwater explosions. Many of the theories and concepts presented herein are applicable to other types of water waves, in particular, tsunamis and waves generated by the fall of a meteorite. Linear and nonlinear theories, as well as experimental calibrations, are presented for cases of deep and shallow water explosions. Propagation of transient waves on dissipative, nonuniform bathymetries together with laboratory simulations are analyzed and discussed.

A Mathematical Approach

Nonlinear Waves In Bounded Media: The Mathematics Of Resonance

Mathematical Techniques for Water Waves

Proceedings of The Sixth International Conference on Mathematical and Numerical Aspects of Wave Propagation Held at Jyväskylä, Finland, 30 June – 4 July 2003

Linear and nonlinear waves are a central part of the theory of PDEs. This book begins with a description of one-dimensional waves and their visualization through computer-aided techniques. Next, traveling waves are covered, such as solitary waves for the Klein-Gordon and KdV equations. Finally, the author gives a lucid discussion of waves arising from conservation laws, including shock and rarefaction waves. As an application, interesting models of traffic *flow are used to illustrate conservation laws and wave phenomena. This book is based on a course given by the author at the IAS/Park City Mathematics Institute. It is suitable for independent study by undergraduate students in mathematics, engineering, and science programs. This book is published in cooperation with IAS/Park City Mathematics Institute.*

The motion of water is governed by a set of mathematical equations which are extremely complicated and intractable. This is not surprising when one considers the highly diverse and intricate physical phenomena which may be exhibited by a given body of water. Recent mathematical advances have enabled researchers to make major progress in this field, reflected in the topics featured in this volume. Cutting-edge techniques and tools from mathematical analysis have generated strong rigorous results concerning the qualitative and quantitative physical properties of solutions of the governing equations. Furthermore, accurate numerical computations of fully-nonlinear steady and unsteady water waves in two and three dimensions have contributed to the discovery of new types of waves. Model equations have been derived in the long-wave and modulational regime using Hamiltonian formulations and solved numerically. This book brings together interdisciplinary researchers working in the field of nonlinear water waves, whose contributions range from survey *articles to new research results which address a variety of aspects in nonlinear water waves. It is motivated by a workshop which was organised at the Erwin Schrödinger International Institute for Mathematics and Physics in Vienna, November 27-December 7, 2017. The key aim of the workshop was to describe, and foster, new approaches to research in this field. This is reflected in the contents of this book, which is aimed to stimulate both experienced researchers and students alike.*

Now in an accessible paperback edition, this classic work is just as relevant as when it first appeared in 1974, due to the increased use of nonlinear waves. It covers the behavior of waves in two parts, with the first part addressing hyperbolic waves and the second addressing dispersive waves. The mathematical principles are presented along with examples of specific cases in communications and specific physical fields, including flood waves in rivers, waves in glaciers, traffic flow, sonic booms, blast waves, and ocean waves from storms.

The book derives the mathematical basis for the most encountered waves in science and engineering. It gives the basis to undertake calculations required for important occupations such as maritime engineering, climate science, urban noise control, and medical diagnostics. The book initiates with fluid *dynamics basis with subsequent chapters covering surface gravity waves, sound waves, internal gravity waves and waves in rotating fluids, and details basic phenomena such as refraction. Thereafter, specialized application chapters include description of specific contemporary problems. All concepts are supported by narrative examples, illustrations, and case studies. Features:- Explains the basis of wave mechanics in fluid systems. Provides tools for the analysis of water waves, sound waves, internal gravity, and rotating fluid waves through different examples. Includes comprehensible mathematical derivations at the expense of fewer theoretical topics. Reviews cases describable by linear theory and cases requiring nonlinear and wave-interaction theories. Supports concepts with narrative examples, illustrations, and case studies. This book aims at Senior Undergraduates/Graduate students and Researchers in Fluid Mechanics, Applied Mathematics, Mechanical Engineering, Civil Engineering, and Physical Oceanography.*

A Workshop on the Problems in the Theory of Nonlinear Hydrodynamic Waves, May 15-19, 1995, Luminy, France

Cetraro, Italy 2013

Mathematical Models for Simple Harmonic Linear Water Waves

Lectures on Wave Propagation

Water Waves Generated by Underwater Explosion

For graduate students, this book links the theory of the hydrodynamics of waves with applications in hydraulic and offshore engineering. The mathematical development is described lucidly for those new to the topic, and there are ample exercises at the end of each chapter, making this an ideal textbook for courses in the subject.

This book discusses the numerical simulation of water waves, which combines mathematical theories and modern techniques of numerical simulation to solve the problems associated with waves in coastal, ocean, and environmental engineering. Bridging the gap between practical mathematics and engineering, the book describes wave mechanics, establishment of mathematical wave models, modern numerical simulation techniques, and applications of numerical models in engineering. It also explores environmental issues related to water waves in coastal regions, such as pollutant and sediment transport, and introduces numerical wave flumes and wave basins. The material is self-contained, with numerous illustrations and tables, and most of the mathematical and engineering concepts are presented or derived in the text. The book

is intended for researchers, graduate students and engineers in the fields of hydraulic, coastal, ocean and environmental engineering with a background in fluid mechanics and numerical simulation methods.

This monograph provides a comprehensive and self-contained study on the theory of water waves equations, a research area that has been very active in recent years. The vast literature devoted to the study of water waves offers numerous asymptotic models.

This volume includes articles on the mathematical modeling and numerical simulation of various wave phenomena. For many years Waves 2003 and its five prior conferences have been an important forum for discussions on wave propagation. The topic is equally important for fundamental sciences, engineering, mathematics and, in particular, for industrial applications. Areas of specific interest are acoustics, electromagnetics, elasticity and related inverse and optimization problems. This book gives an extensive overview of recent developments in a very active field of scientific computing.

Mathematical Problems in the Theory of Water Waves

Waves in Fluids

A Modern Introduction to the Mathematical Theory of Water Waves

An Interdisciplinary Interface
Ocean Waves and Oscillating Systems

Linear Water WavesA Mathematical ApproachCambridge University Press

The proceedings featured in this book grew out of a conference attended by 40 applied mathematicians and physicists which was held at the International Center for Research in Mathematics in Luminy, France, in May 1995. This volume reviews recent developments in the mathematical theory of water waves. The following aspects are considered: modeling of various wave systems, mathematical and numerical analysis of the full water wave problem (the Euler equations with a free surface) and of asymptotic models (Korteweg-de Vries, Boussinesq, Benjamin-Ono, Davey-Stewartson, Kadomtsev-Petviashvili, etc.), and existence and stability of solitary waves. It features: the latest developments in the theory of water waves; rigorous and formal results; and, papers from world-renowned experts in the field.

This overview of some of the main results and recent developments in nonlinear water waves presents fundamental aspects of the field and discusses several important topics of current research interest. It contains selected information about water-wave motion for which advanced mathematical study can be pursued, enabling readers to derive conclusions that explain observed phenomena to the greatest extent possible. The author discusses the underlying physical factors of such waves and explores the physical relevance of the mathematical results that are presented. The material is an expanded version of the author's lectures delivered at the NSF-CBMS Regional Research Conference in the Mathematical Sciences organized by the Mathematics Department of the University of Texas-Pan American in 2010.

The objective of this book is to introduce new researchers to the rich dynamical system of water waves, and to show how (some) abstract mathematical concepts can be applied fruitfully in a practical physical problem and to make the connection between theory and experiment. It provides a coherent set of lectures on the current status of water wave theory, including identification of some open problems.

An Introduction to Hydrodynamics and Water Waves

Water Waves: The Mathematical Theory with Applications

Nonlinear Water Waves

An Introduction to the Mathematical Theory of Waves

The Water Waves Problem

In this book an introduction is given to aspects of water waves that play a role in ship hydrodynamics and offshore engineering. At first the equations and linearized boundary conditions are derived describing the non-viscous free surface water waves, with special attention to the combination of steady and non-steady flow fields. Then some simple kinds of free wave solutions are derived, such as plane waves and cylindrical waves. For several situations, steady and unsteady, the source singularity function is derived. These functions play a role in numerical codes used to describe the motion of ships and offshore structures. These codes are mostly based on a boundary integral formulation; therefore we give an introduction to these methods. It is shown how first order ship motions can be determined. In offshore engineering the second order wave drift motions play an important role. An introduction to this phenomenon is given and the effects which have to be taken into account are explained by means of a simple

example where we can determine nearly all the aspects analytically. An interesting example that is worked out is the motion of very large floating flexible platforms with finite draft. Finally an introduction to the theory of shallow water non-linear dispersive waves is presented, and shallow water ship hydrodynamics, that plays a role in coastal areas and channels is treated. Here attention is paid to the interaction between passing ships in restricted water. In the appendix a short introduction to some of the mathematical tools is given.
Linear Interactions Including Wave-Energy Extraction
Numerical Simulation of Water Waves
Proceedings of the Conference on Water Waves: Theory and Experiment, Howard University, USA, 13-18 May 2008
Strichartz Estimates and the Cauchy Problem for the Gravity Water Waves Equations
Fluid Waves