Preface to the Expanded Edition

This is Part One of the expanded edition of *Applied Dynamics of Ocean Surface Waves* by CCM first published twenty two years ago by Wiley-Interscience. A corrected version was later published by World Scientific without essential changes. During the past two decades, many theoretical advances have been made by researchers throughout the world. Great strides have been made in analytical and numerical treatments for accurate predictions as well as physical understanding. In this new edition, the authors have added considerable new materials, hence the division to two separate parts.

Part One is restricted to the linear aspects. While nearly all the matierials in the first edition are kept, many new exercises are added. A major change is the addition of Chapter 7 on the multiple scattering by many scatterers on the seabed. Introductory aspects of Bragg resonance by periodic bars are first discussed. Important to coastal geomorphology, a complete understanding of longshore bars requires quantitative understanding of both the cause and the effect; it turns out that waves and bars affect each other in complicated ways. The formation and evolution of sandbars under waves is, however, a very slow process and involves the highly empirical science of sediment transport; we only discuss the linearized effects of rigid bars on the wave climate. Over a much larger scale of the continental shelf, bathymetric variations can be very irregular. Therefore we also present a new theory of the effects of scattering by random depth fluctuations. It is shown that the accumulation of incoherent scattering over an extended area results in energy removal from the averaged motion which is coherent. This physics is related to the phenomenon of Anderson localization in quantum physics.

In Chapter 8 on the dynamics of floating bodies, we have included a section on the trapped modes of the mobile gates designed for Venice lagoon, as a current application in coastal engineering.

The science of water waves has always been enriched by the use of mathematical tools. In order that a reader with only some familiarity with advanced calculus can make effective use of this book, we have continued the style of the previous edition by shunning the phrase "it can be shown that...". Often the mathematical steps of derivation are given in considerable detail. More advanced tools such as the techniques of asymptotic analysis are explained in the text. To highlight our objectives of bridging theory and applications, the title of this book has been changed.

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Preface to the First Edition

A substantial growth of knowledge in the dynamics of ocean surface waves has been witnessed over the past 20 years. While many advances have been stimulated by purely scientific inquiry in geophysics, the pace of progress has also been quickened by the increase in large engineering projects both offshore and along the coast. A major construction project now demands not only careful estimates of wave conditions near the site but also reliable predictions of the effects on and of the construction itself. With a view to bringing together scientific and engineering aspects of ocean waves, educational and research programs have naturally been established in a number of universities and industries.

This book is the outgrowth of my lecture notes for a two-semester course taught at M.I.T. since 1974 to graduate students in civil and ocean engineering, with occasional participants from physical oceanography. The aim of the book is to present selected theoretical topics on ocean-wave dynamics, including basic principles and applications in coastal and offshore engineering, all from the deterministic point of view. The bulk of the material deals with the linearized theory which has been well developed in the research literature. The inviscid linearized theory is covered in Chapters One to Five and again in Eight. Frictional effects caused directly or indirectly by viscosity are treated in Chapters Six, Nine, and Ten. A special effect of breaking waves on beaches is examined in Chapter Eleven. Chapters Ten and Eleven focus on the secondary effects of nonlinearity. The cases where nonlinearity is of primary importance are the subjects of Chapters Twelve and Thirteen, for shallow and deep waters, respectively. The last chapter (Fourteen) is on wave-induced stresses in a porous but deformable seabed, which is a problem vital to offshore engineering. In the construction of a gravity platform, the cost of the foundation alone can be as high as 40% of the total. Under the influence of waves, the strength of a porous seabed is affected to varying degrees by fluid in the pores. Hence hydrodynamics is an essential part of the problem. In this chapter a well-known fluid-dynamic reasoning is applied to a soil model which includes fluid and solid phases. I hope the material will stimulate further interaction among researchers in different disciplines.

Most parts of this book have been used either for my own lectures or for self-paced reading by the students. Since contributions by mathematical scientists have always been prominent in this field, the use of certain analytical techniques which may be less familiar to many potential readers cannot be avoided. Therefore, considerable space is devoted to the informal explanation and demonstration of those techniques not customarily discussed in a course on advanced calculus. The derivations of most of the results are given in detail in order to reduce possible frustrations to those who are still acquiring the requisite skills. A few exercises are included; nearly all of them demand some effort. For additional exercises, I have usually suggested term papers based on the student's own survey of literature.

Studies on waves in general, and on water waves in particular, have always been enriched by cross fertilization among diverse fields of science and engineering, including physics, mathematics, oceanography, electrical engineering, and others. A conscientious effort has been made in this book to reflect this fact which I hope will induce more engineers and scientists to join their talents for further challenges of the sea.

Several important areas which are either beyond my own experience or have been treated in other books are not included here. The mechanisms of wave generation by wind and many aspects of resonant interactions have been admirably surveyed by Phillips (1977) and by LeBlond and Mysak (1978). On the statistical *description* of random sea waves, a detailed discussion of the basic aspects may be found in Price and Bishop (1974). For the statistical *mechanics* of sea waves one should consult Phillips (1977) and West (1981). The rapid advance on steep waves, spearheaded by M. S. Longuet-Higgins, is of obvious interest to engineers and oceanographers alike; the numerous papers by him and his associates on the subject cannot be matched for clarity and thoroughness. Waves due to advancing bodies belong to the realm of ship hydrodynamics; the definitive treatises by Stoker (1957), Wehausen and Laitone (1960), and Newman (1977), and all the past proceedings of the Naval Hydrodynamics Symposium should be consulted. Wave-induced separation around small bodies is at the heart of force prediction for offshore structures; it is a subject where experiments play the leading role and has been expertly covered in a recent book by Sarpkaya and Issacson (1981). Storm surges are also omitted.

In a book containing many mathematical expressions, freedom from error can be strived for but is hard to achieve. I shall be grateful to readers who wish to inform me of any oversights that remain.

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