“Electronic” pages (title page, preface and contents) of:

TOPICS ON EXTRACTION OF OCEAN-WAVE ENERGY

Various Leftover Lecture Notes

by

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Preface and summary

My textbook "Ocean Waves and Oscillation Systems: Linear interactions including wave-energy extraction" (Cambridge University Press, 2002, ISBN 0-521-78211-2) was published two months ago. From the Preface of this textbook (below referred to as OWOS) I cite the following:
"*The present book is mainly based on lecture notes from a postgraduate university course on water waves and extraction of energy from ocean waves, which I have taught many times since 1979. For the purposes of this book, I have selected those parts of the subject which have more general interest, rather than those parts of my course which pertain to wave-power conversion in particular. I hope that the book is thus of interest to a much wider readership than just the wave-energy community*."

The leftover parts are collected in the present issue entitled "Topics on Extraction of Ocean-Wave Energy". These parts are simply copied from my previous lecture notes, made available in 1993 as a two-volume work entitled "Theory for extraction of ocean-wave energy". On the copied pages, I have (between lines) written (by hand) references to chapters, sections and equations in the textbook OWOS.

The following chapters were included in my 1993 lecture notes:
A. Mathematical description of oscillations and waves
B. Potential theory for an ideal incompressible fluid
S. Statistics and energy transport of real ocean waves
D. Interaction between a harmonic wave and an oscillating body
E. Excitation force on a single body
O. Interaction between a harmonic wave and an oscillating water column (OWC)
P. Interaction of waves with oscillating bodies and OWCs
K. Parallel rows of oscillating bodies and OWCs
T. Time-invariant linear systems

All matter of chapters A and E is included in OWOS, in chapters 2 and 3 and in section 5.6, respectively. Almost all matter of chapters B, O, P and T is included in OWOS, in chapter 4 (B), in chapter 7 (O and P) and in sections 2.5, 2.6, 5.3, 5.9 and 6.3 (T). Significant parts of chapter D are included in chapters 5 and 6 of OWOS. From chapter S only some basic matter is included in OWOS, in section 4.5. Except for figure K10, the matter of chapter K is not included in OWOS. As compared with my 1993 lecture notes, the new textbook OWOS contains substantial additional matter in chapters 2, 4, 5 and 6.

The present issue contains the following leftover portions from my previous lecture notes:

Pages 1-5 (from chapter B) covers non-linear boundary conditions at the water-air interface.

Pages 6-27 contain most of chapter S, that is matter on wave spectra, spectrum moments, wave-energy transport and short-term wave statistics. Pages 28-30 contain problem S4 (not included in OWOS) with hand-written solution.

Pages 31-36 (from chapter D) give examples of two wave generators without added mass. The first example might be considered as an introduction to subsection 5.2.3 of OWOS, while the second example is an extension. The figure on page 37 is an illustration to equation (5.79) in the same subsection.

Pages 38-40, which give an OWC extension to matter -- equation (5.328) and figure 5.27 -- in subsection 5.9.1, might also be considered as part of introduction to chapter 7 of OWOS.

Pages 40-56 contain matter (from chapter D) on phase control and on experiments with point absorbers in a wave channel. This matter is an extension to sections 6.2 and 6.3 of OWOS.

Pages 57-59 present an alternative to the applied-pressure description introduced in section 7.1 of OWOS. This alternative is a description which is similar to (but avoids the approximating disadvantage of) the oscillating-body description of an OWC.

Pages 60-67 (from chapter P) give a derivation that generalises eq. (5.88) to the case where OWCs are included in the system, in addition to the oscillating bodies. Note that this derivation is different from (and thus an alternative to) the derivation used in subsection 5.5.4. Pages 60-67 might be considered as an extension to section 7.2 of OWOS. This extension provides, i.a., a proof of the stated relation (7.29).

The whole of chapter K is contained on pages 68-103, and problem K4 with solution on pages 104-105. The chapter treats the theory of absorption of waves by infinitely long arrays of evenly spaced groups of oscillating bodies and OWCs. The theory for two-dimensional systems (e.g. terminators like the original Salter Duck) follows as a particular case. Thus chapter K could perhaps be considered as an extension of section 5.8 and of subsection 6.4.3 or as an extension of section 7.2 in OWOS.

Pages 106-111 (last pages of chapter T) could be considered as an extension of section 6.3.

Pages 112-119 contain matter from my lecture notes 1979, included in a bound volume entitled "Hydrodynamisk teori for bølgjekraftverk" ("Hydrodynamic theory for wave power plants") by L.C. Iversen and me. It was published in 1980 by the University of Trondheim, Division of Experimental Physics, in 100 copies. This matter was not included in my 1993 lecture notes in English. When students from the Mechanical, Marine or Civil Engineering Faculties attended my postgraduate course, this matter was not included in my lectures. In 1979 only Physics students attended.
The content of pages 112-119 could be summarised as follows. Starting with the electric and magnetic field components (near field plus far field) from an oscillating electric dipole, the radiated power (A92) is derived. Based on the relation (A89) between the complex amplitudes of the dipole moment p and the corresponding electric current I, the dipole is a model of a "Hertz dipole", which is an infinitesimal antenna. This antenna's (electric) radiation resistance (A94) is derived, as well as the radiation resistance (A95a) for a finite antenna. Then the absorption cross section A_a for a Hertz dipole is derived. Finally, the interaction of light with an atom is considered, using classical (not quantum-mechanical) theory. The atom's damping coefficient d, resonance bandwidth G, natural (spectral) line-width Δl, and (mechanical) radiation resistance R_r are derived.

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Contents

Ocean energy technologies are still relatively immature, but they continue to advance. After years with development of only small pilot ocean energy projects, global capacity almost doubled in 2011 with the addition of about 254 MW. Almost all of this capacity began operation off the shores of South Korea, and it brought total global ocean energy capacity (most of which is tidal power) to 527 MW.Â Because wave energy is maximized at high latitudes and on the western continental coasts, research on wave energy extraction has been carried on for several decades by Norway and the United Kingdom. The thermal gradient between warm tropical surface waters and cold deep waters below has been shown to support a low pressure thermal power plant. Ocean waves are converted to electricity with wave energy converter, or WEC, devices. Researchers expect typical full-scale WEC devices to be anchored miles offshore in deep water where wave energy is strongest. Because WECs extract energy from waves of all sizes that move in multiple directions, identifying the type of machine that can most-effectively do this work is a key goal of the U.S. Department of Energy. The Wave Energy Prize, an 18-month competition that advanced the energy capture potential of WECs, highlighted a variety of promising devices. Grand-prize winner AquaHarmonics, for ex