7TH EDITION

THE FINITE ELEMENT METHOD FOR FLUID DYNAMICS

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Seventh Edition

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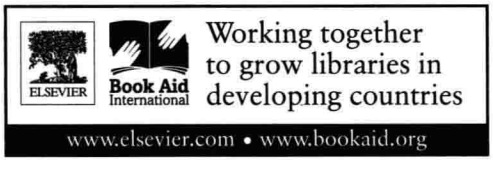

The Finite Element Method for Fluid Dynamics

Professor O.C. Zienkiewicz, CBE, FRS, FREng died on January 2, 2009. Prior to his death he was Professor Emeritus at the Civil and Computational Engineering Centre, University of Wales, Swansea and previously was Director of the Institute for Numerical Methods in Engineering at the University of Wales, Swansea, UK. He also held the UNESCO Chair of Numerical Methods in Engineering at the Technical University of Catalunya, Barcelona, Spain. He was the head of the Civil Engineering Department at the University of Wales, Swansea between 1961 and 1989. During this period he established that department as one of the primary centers of finite element research. In 1968 he became the Founder Editor of the *International Journal for Numerical Methods in Engineering* which still remains today the major journal in this field. The recipient of 27 honorary degrees and many medals, he was a member of five academies—an honor he received for his many contributions to the fundamental developments of the finite element method. In 1978, Professor Zienkiewicz became a Fellow of the Royal Society and the Royal Academy of Engineering. This was followed by his election as a foreign member to the US Academy of Engineering (1981), the Polish Academy of Science (1985), the Chinese Academy of Sciences (1998), and the National Academy of Science, Italy (Academia dei Lincei) (1999). He published the first edition of this book in 1967 and it remained the only book on the subject until 1971.

Professor R.L. Taylor has more than 50 years' experience in the modeling and simulation of structures and solid continua including 8 years in industry. He is Professor of the Graduate School and the Emeritus T.Y. and Margaret Lin Professor of Engineering at the University of California at Berkeley and also Corporate Fellow at Dassault Systèmes SIMULIA in Providence, Rhode Island. In 1991 he was elected to membership in the US National Academy of Engineering in recognition of his educational and research contributions to the field of computational mechanics. He is a Fellow of the US Association of Computational Mechanics—USACM (1996) and a Fellow of the International Association of Computational Mechanics—IACM (1998). He has received numerous awards including the Berkeley Citation, the highest honor awarded by the University of California at Berkeley, the USACM John von Neumann Medal, the IACM Gauss-Newton Congress Medal, and a Dr.-Ingenieur ehrenhalber awarded by the Technical University of Hannover, Germany. He has written several computer programs for finite element analysis of structural and nonstructural systems, one of which, *FEAP*, is used worldwide in education and research environments. A personal version, *FEAPpv*, available at his UC website, is incorporated into this book.

Professor P. Nithiarasu has over 20 years' experience in finite element–based computational fluid dynamics research. He moved to Swansea in 1996 after completing his PhD research at IIT Madras and is currently Professor in the Civil and Computational Engineering Centre at Swansea University. He was awarded the Zienkiewicz silver medal and prize of the Institution of Civil Engineers, UK in 2002. In 2004 he was selected to receive the European Community on Computational Methods in Applied Sciences (ECCOMAS) award for young scientists in computational engineering sciences. He is the author of nearly 300 articles in the area of fluid dynamics, porous medium flows, and the finite element method. He is the founding editor of the International Journal for Numerical methods in Biomedical Engineering.

This book is dedicated to the memory of
Olgierd C. (Olek) Zienkiewicz:
Pioneer, mentor, and close friend.

List of Figures