The Finite Volume Method in Computational Fluid Dynamics: An Advanced Introduction with OpenFOAM® and Matlab (Fluid Mechanics and Its Applications)

By F. Moukalled, L. Mangani, M. Darwish

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This textbook explores both the theoretical foundation of the Finite Volume Method (FVM) and its applications in Computational Fluid Dynamics (CFD). Readers will discover a thorough explanation of the FVM numerics and algorithms used for the simulation of incompressible and compressible fluid flows, along with a detailed examination of the components needed for the development of a collocated unstructured pressure-based CFD solver. Two particular CFD codes are explored. The first is uFVM, a three-dimensional unstructured pressure-based finite volume academic CFD code, implemented within Matlab. The second is OpenFOAM®, an open source framework used in the development of a range of CFD programs for the simulation of industrial scale flow problems.

With over 220 figures, numerous examples and more than one hundred exercise on FVM numerics, programming, and applications, this textbook is suitable for use in an introductory course on the FVM, in an advanced course on numerics, and as a reference for CFD programmers and researchers.

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Editorial Review

Review

"The book is very attractive, carefully written and easy to read by those interested in learning about finite volume methods for fluid dynamics. The authors have made an important effort to bridge the gap between classroom material and actual model development questions. The text is well illustrated by means of quality figures helping to understand the described concepts. Furthermore, the book contains pieces of academic codes in MATLAB … . It is certainly a useful, practical and valuable book." (Pilar Garcia-Navarro, Mathematical Reviews, May, 2016)

From the Back Cover

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About the Author

Fadl Moukalled received his PhD degree in Mechanical Engineering from Louisiana State University in 1987. During that same year he joined the Mechanical Engineering Department at the American University of Beirut where currently he serves as a Professor. He is research interests cover several aspects of the finite volume method and its use in computational fluid dynamics. A founding member of the CFD Group at AUB, he worked on convection schemes, pressure based segregated algorithms for incompressible and compressible flows, adaptive grid methods, multigrid methods, transient schemes for free surface flows, multiphase flows, and fully coupled pressure based solvers for incompressible, compressible, and multiphase flows.

Luca Mangani received his PhD degree form the University of Florence in 2006, where he worked on the development of a state-of-the-art turbo machinery code in OpenFOAM® for heat transfer and combustion analysis. After three years of post-doc work, he joined the Lucerne University of Applied Sciences and Arts as Senior Research and chief engineer for CFD simulations. Since 2014 he is serving as an Associate Professor at the fluid mechanics and hydro-machines department, where he manages a variety of projects with industrial partners aimed at developing advanced and novel CFD tools. His research interests include pressure and density-based solvers, segregated and fully coupled algorithms, fluid-structure interaction (FSI),

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Marwan Darwish received his PhD degree in Materials Processing from BRUNEL University in 1991. He then joined the BICOM institute for one year as a post-doc before joining the Mechanical Engineering Department at the American University of Beirut in 1992, where he currently serves as a Professor. His research interest covers a range of topics including solidification, advanced numerics, free surface flow, high resolution schemes, multiphase flows, coupled algorithms, and algebraic multigrid. He is a founding member of the CFD Group at AUB.

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