<<计算流体动力学导论>>

图书基本信息

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前言

We were pleasantly surprised by the ready acceptance of the first edition of our book by the CFD community and by the amount of positive feedback received over a period of 10 years. To us this has provided justification of our original plan, which was to provide an accessible introduction to this fast-growing topic to support teaching at senior undergraduate level, post- graduate research and new industrial users of commercial CFD codes. Our second edition seeks to enhance and update. The structure and didactic approach of the first edition have been retained without change, but aug- mented by a selection of the most important developments in CFD.In our treatment of the physics of fluid flows we have added a summary of the basic ideas underpinning large-eddy simulation （LES） and direct numerical simulation （DNS）. These resource-intensive turbulence predic- tion techniques are likely to have a major impact in the medium term on CFD due to the increased availability of high-end computing capability.Over the last decade a number of new discretisation techniques and solution approaches have come to the fore in commercial CFD codes. To reflect these developments we have included summaries of TVD techniques, which give stable, higher-order accurate solutions of convection-diffusion problems, and of iterative techniques and multi-grid accelerators that are now commonly used for the solution of systems of discretised equations. We have also added examples of the SIMPLE algorithm for pressure-velocity coupling to illustrate its workings.At the rime of writing our first edition, CFD was firmly established in the aerospace, automotive and power generation sectors. Subsequently, it has spread throughout engineering industry. This has gone hand in hand with major improvements in the treatment of complex geometries. We have devoted a new chapter to describing key aspects of unstructured meshing techniques that have made this possible.Application of CFD results in industrial research and design crucially hinges on confidence in its outcomes. We have included a new chapter on uncertainty in CFD results. Given the rapid growth in CFD applications it is difficult to cover, within the space of a single introductory volume, even a small part of the submodelling methodology that is now included in many general-purpose CFD codes. Our selection of advanced application material covers combustion and radiation algorithms, which reflects our local perspec- tive as mechanical engineers with interest in internal flow and combustion.

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内容概要

本书是一本非常实用的计算流体动力学教材，它以简明、清晰的语言介绍了计算流体动力学的基本原理、控制方程、边界条件、湍流及其模式、有限体积法等。
在保持第一版基本结构和写作风格基础上，增加了一部分介绍CFD重要发展；在处理流体流方面，增加了支持LES和DNS的基本观点的综述，使得内容结构更加完整。
重点介绍了目前在各类流行商业软件中普遍采用的基于压力求解体系的有限体积法。
本书的最大特点是弥补了理论与商用软件之间的差距，使读者通过该书的学习能够掌握应用广泛的PHOENICS，FLOW-3D和STAR-CD等计算编码中的基本理论。
目次：绪论；流体运动守恒律与边界条件；湍流及其模式；扩散问题的有限体积方法；对流－扩散问题的有限体积法；压力－速度耦合在定常问题中的算法；离散方程的求解；非定常流动的有限体积方法；边界条件提法；CFD模型的误差和不确定度；处理复几何的方法；燃烧的CFD模型；放射热传导的数值计算。

书籍目录

章节摘录

插图：The discussion of the k-e turbulence model, to which we return later, the material in Chapters 2 and 3 is largely self-contained. This allows the use of this book by those wishing tO concentrate principally on the numerical algorithms, but requiring an overview of the fluid dynamics and the math- ematics behind it for occasional reference in the same text.The second part of the book is devoted to the numerical algorithms of the finite volume method and covers Chapters 4 to 9. Discretisation schemes and solution procedures for steady flows are discussed in Chapters 4 to 7. Chapter 4 describes the basic approach and derives the central difference scheme for diffusion phenomena. In Chapter 5 we emphasise the key prop- erties of discretisation schemes, conservativeness, boundedness and trans- portiveness, which are used as a basis for the further development of the upwind, hybrid, QUICK and TVD schemes for the discretisation of con- vective.terms. The non-linear nature of the underlying flow phenomena and the linkage between pressure and velocity in variable density fluid flows requires special treatment, which is the subject of Chapter 6. We introduce the SIMPLE algorithm and some of its more recent derivatives and also discuss the PISO algorithm. In Chapter 7 we describe algorithms for the solution of the systems of algebraic equations that appear after the discret- isation stage. We focus our attention on the well-known TDMA algorithm, which was the basis of early CFD codes, and point iterative methods with multigrid accelerators, which are the current solvers of choice.The theory behind all the numerical methods is developed around a set of worked examples which can be easily programmed on a PC. This pres- entation gives the opportunity for a detailed examination of all aspects of the discretisation schemes, which form the basic building blocks of practical CFD codes, including the characteristics of their solutions.In Chapter 8 we assess the advantages and limitations of various schemes to deal with unsteady flows, and Chapter 9 completes the development of the numerical algorithms by considering the practical implementation of the most common boundary conditions in the finite volume method.The book is primarily aimed to support those who have access to a CFD package, so that the issues raised in the text can be explored in greater depth. The solution procedures are nevertheless sufficiently well documented for the interested reader to be able to start developing a CFD code from scratch.The third part of the book consists of a selection of topics relating to the application of the finite volume method to complex industrial problems. In Chapter 10 we review aspects of accuracy and uncertainty in CFD. It is not possible to predict the error in a CFD result from first principles, which creates some problems for the industrial user who wishes to evolve equip- ment design on the basis of insights gleaned from CFD. In order to address this issue a systematic process has been developed to assist in the quantifica- tion of the uncertainty of CFD output. We discuss methods, the concepts of verification and validation, and give a summary of rules for best practice that have been developed by the CFD community to assist users. In Chapter 11 we discuss techniques to cope with complex geometry. We review various approaches based on structured meshes: Cartesian co-ordinate systems, gen- eralised co-ordinate systems based on transformations, and block-structured grids, which enable design of specific meshes tailored to the needs of dif- ferent parts of geometry. We give details of the implementation of the finite volume method on unstructured meshes. These are not based on a grid of lines to define nodal.

编辑推荐

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