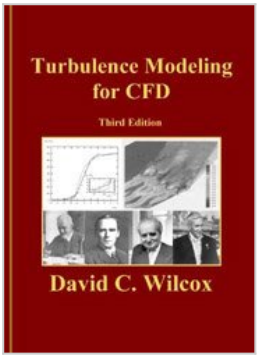

Turbulence Modeling for CFD (Third Edition)

By David C. Wilcox

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As in the first and second editions, the book revolves around the fact that turbulence modeling is one of three key elements in CFD. Very precise mathematical theories have evolved for the other two, viz., grid generation and algorithm development. By its nature, i.e., creating a mathematical model that approximates the physical behavior of turbulent flows, far less precision has been achieved in turbulence modeling. This text addresses the problem of selecting/devising such models. The fundamental premise is, in the spirit of G. I. Taylor, an ideal model should introduce the minimum amount of complexity while capturing the essence of the relevant physics.

The text begins with the simplest models and charts a course leading to some of the most complex models that have been applied to a nontrivial flow. Along the way, a systematic methodology is presented for developing and analyzing turbulence models. The methodology makes use of tensor calculus, similarity solutions, singular perturbation methods, and numerical procedures. The text stresses the need to achieve a balance amongst the physics of turbulence, mathematical tools required to solve turbulence-model equations, and common numerical problems attending their use (i.e., what good is a model if it makes your program crash?). Several user friendly programs and detailed user's guides are provided on the Compact Disk that accompanies the text.

Many of the applications are used throughout the text to permit comparison of complicated models with simpler models. A completely objective point of view is taken in assessing the merits of models and their range of applicability. The text includes an extensive Bibliography, a detailed Index and well thought out homework problems of varying degrees of difficulty.

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Editorial Review

From the Publisher
Publication of the Third Edition of **Turbulence Modeling for CFD** has been motivated by its continuing popularity and Dr. Wilcox's desire to document his recent contributions to the field. It has been adopted for course use in universities all around the world and Dr. Wilcox has presented a short course based on the book many times in the United States and beyond. Demand for the book continues to exceed all expectations.

What's New?...

All chapters and appendices have undergone improvement and expansion. Most notably, Chapter 4 presents a new version of the k-omega model that includes cross diffusion and a stress limiter. These innovations, inspired by the research of Johan Kok and George Huang, have led to significant improvement of predictive accuracy. The new k-omega model yields close agreement with measurements for boundary layers with pressure gradient, classical free shear flows and separated flows. The improved k-omega model should provide improved predictive accuracy for complex turbulent flows as well as being a source of fresh research ideas.

Inclusion of a stress limiter in a unique way yields excellent agreement between computed and measured properties of shock-separated flows from transonic to hypersonic speeds. Recent advances and successes in devising and applying nonlinear stress/strain-rate relations are included in Chapter 6, which also presents a revised stress-transport (second-order closure) model based on the omega equation. The discussion of DNS and LES in Chapter 8 has been expanded and DES has been added. Finally, to enhance the book's utility in the classroom, the number of homework problems has increased by 25%.

As with previous editions, the book comes with a companion Compact Disk (CD) that contains source code and documentation for several useful computer programs. In addition to the software provided with the first and second editions, the CD includes a two-dimensional/axisymmetric Navier-Stokes program and some simple grid-generation software. The CD also contains experimental and DNS data in digital form to aid users who wish to compare their own turbulent-flow predictions with measurements.

The software on the CD has been modernized and optimized for personal computers running the Microsoft Windows operating system. All programs have menu-driven input-data preparation and plotting utilities, written entirely in Visual C++, that provide a user-friendly environment.

From the Author
For me, this edition represents a mission accomplished. It's a mission I scoped out for myself three decades ago when I was fresh out of Caltech. What was that mission? To develop a set of turbulence-model equations that, with an absolute minimum of complexity, would accurately compute properties of a series of roughly 100 test cases.

Over the years I have assembled a set of test cases that I deem essential for validating a useful engineering tool. The test cases include attached boundary layers, free shear flows, backward-facing steps and shock-separated flows to mention a few, most dealing with Mach numbers from incompressible speeds to hypersonic.

The third edition presents a version of the k-omega model that yields close agreement with measurements for all 100 test cases. And it does all of this with just 6 closure coefficients and no compressibility corrections!

About the Author

David C. Wilcox was born in Wilmington, Delaware. He was educated as an aeronautical engineer at the Massachusetts Institute of Technology (BS 1966) and the California Institute of Technology (PhD 1970). After spending the early part of his career with several Southern California aerospace companies, in 1973, he founded DCW Industries, Inc., for which he is currently the President. He has taught several aerospace and mechanical engineering courses at both USC and UCLA.

In the early 1990s, Dr. Wilcox shifted the focus of his corporation from defense contracting to book publishing. Building on an international reputation based on numerous scientific-journal publications, he has written and published two undergraduate fluid-mechanics texts entitled **Basic Fluid Mechanics** (1997, 2000, 2007) and **Elements of Fluid Mechanics** (2005). He has also written two graduate-level texts entitled **Turbulence Modeling for CFD** (1993, 1998, 2006) and **Perturbation Methods in the Computer Age** (1995). These books are currently in use at universities throughout the world.

Dr. Wilcox has also written three nontechnical books, the most recent of which is a partial autobiography entitled **An Improbable Life** (2007). The other two books are a fictional novel about a political compaign, **. . . And the Donkey They Rode in On** (2001), and collection of essays about politics entitled **Cliches of Liberalism** (1999).

Users Review

From reader reviews:

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