# Preface

Ready access to computers has defined a new era in teaching and learning. The opportunity to extend the subject matter of traditional science and engineering curricula into the realm of scientific computing has become not only desirable, but also necessary. Thanks to portability and low overhead and operating cost, experimentation by numerical simulation has become a viable substitute, and occasionally the only alternative, to physical experimentation.

The new framework has necessitated the writing of texts and monographs from a modern perspective that incorporates numerical and computer programming aspects as an integral part of the discourse. Under this modern approach, methods, concepts, and ideas are presented in a unified fashion that motivates and underlines the urgency of the new elements, but neither compromises nor oversimplifies the rigor of the classical discourse.

Interfacing fundamental concepts and practical methods of scientific computing can be implemented at different levels. In one approach, theory and implementation are kept complementary and presented in a sequential fashion. In another approach, the coupling involves deriving computational methods and simulation algorithms, and translating equations into computer code instructions immediately following problem formulations. Seamlessly interjecting methods of scientific computing in the traditional discourse offers a powerful venue for developing analytical skills and obtaining physical insight.

My goal in this book is to offer an introductory course in traditional and modern fluid mechanics, covering topics in a way that unifies theory, computation, computer programming, and numerical simulation. The approach is truly introductory in that only a few prerequisites are required. The intended audience includes undergraduate and entry-level graduate students, as well as a broader class of scientists, engineers, fluid dynamics and computational science enthusiasts with a general interest in computing. This book should be especially appealing to those who are making a first excursion into the world of numerical computation and computational fluid dynamics (CFD) beyond the black-box and drop-down menu approach. This book should be an ideal text for an introductory course in fluid mechanics and CFD.

The presentation of the material is distinguished by two features. First, solution procedures and algorithms are developed immediately after problem formulations are presented, and illustrative MATLAB® codes are listed and discussed in the text. Second, numerical methods are introduced on a need-to-know basis and in order of ascending difficulty: function interpolation, function differentiation, function integration, solution of algebraic equations, finite-difference methods, etc. Computer problems at the end of each section require performing computation and simulation to study the effect of various parameters determining a flow.

In concert with the intended usage of this book as a stand-alone introductory text and as a tutorial on numerical fluid dynamics and scientific computing, only a few references are

provided in the discussion. Instead, a selected compilation of introductory, advanced, and specialized texts on fluid dynamics, calculus, numerical methods, and computational fluid dynamics are listed in Appendix B. The reader who wishes to focus on a particular topic is directed to these resources for further details.

### FDLIB

A major feature of this book is the accompanying fluid dynamics software library FDLIB discussed in Appendix A. The FORTRAN 77 and MATLAB programs of FDLIB explicitly illustrate how computational algorithms translate into computer instructions. The codes of FDLIB range from introductory to advanced, and the topics span a broad range of applications discussed in this text: from laminar channel flows, to vortex flows, to flow past airfoils. The MATLAB codes of FDLIB combine numerical computation, graphics display, data visualization and animation.

To run the FORTRAN 77 codes of FDLIB, a FORTRAN 77 or FORTRAN 90 compiler is required. Free compilers are available thanks to the gnu foundation. The input data is either entered from the keyboard or read from data files. The output is recorded in output files in tabular form so that it can be read and displayed using independent graphics, visualization, and animation applications on any computer platform, including MATLAB.

### Third edition

The third edition incorporates significant enhancements and improvements. Further examples, clarifications, solved problems, and new material have been added for a more comprehensive treatment of the various topics. Additional MATLAB programs integrating numerical computation and graphics visualization are listed and discussed in the text. The revised text refers to the latest version of the accompanying library FDLIB. The integrated approach pursued in this book overrides the Graphical User Interface or black-box approach, which is often misrepresented as an educational or learning tool. The book Internet site is located at: http://dehesa.freeshell.org/FD3

C. Pozrikidis

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Pozrikidis, C.
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