Aerodynamics for Engineers

Sixth Edition

Now reissued by Cambridge University Press, this sixth edition covers the fundamentals of aerodynamics using clear explanations and real-world examples. Aerodynamics concept boxes throughout showcase real-world applications, chapter objectives provide readers with a better understanding of the goal of each chapter and highlight the key "take-home" concepts, and example problems aid understanding of how to apply core concepts. Coverage also includes the importance of aerodynamics to aircraft performance, applications of potential flow theory to aerodynamics, high-lift military airfoils, subsonic compressible transformations, and the distinguishing characteristics of hypersonic flow.

Supported online by a solutions manual for instructors, MATLAB® files for example problems, and lecture slides for most chapters, this is an ideal textbook for undergraduates taking introductory courses in aerodynamics, and for graduates taking preparatory courses in aerodynamics before progressing to more advanced study.

John J. Bertin, deceased, was Professor Emeritus of Aeronautics at the U.S. Air Force Academy, formerly holding positions at NASA, The University of Texas at Austin, and Sandia National Laboratories.

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Preface

A great deal has happened since the preface to the fifth edition of *Aerodynamics for Engineers* was written early in 2008. During the spring and early summer of 2008, John Bertin and I were busy checking chapter proofs for "The Book" (as he liked to call it). John was at home in Houston and teaching at his beloved Rice University (you may have noticed that covers of the various editions of *Aerodynamics for Engineers* were usually blue and light gray, the colors of Rice University). I was a visiting researcher at the Institute of Aerodynamics and Flow Technology at The German Aerospace Center (DLR) in Braunschweig. John had two major struggles in his life at the time: he was working through the last stages of the illness that would take his wife, Ruth, from him. He had also been diagnosed with pancreatic cancer, and was dealing with doctors, treatments, and hospitals. We spoke on the phone often about the various challenges he was facing, both with his wife's and his own health. Through the support of his family, as well as his desire to finish the fifth edition, he made it through the summer of 2008 in reasonably good shape. Copies of the book were shipped to us in July 2008, and he was very glad that we had finished the undertaking we had started so many years earlier.

Unfortunately, John's pancreatic cancer took a turn for the worse in late summer of 2008, and he passed away on October 11, 2008. A large number of former co-workers from NASA and various universities, as well as his family and friends, attended his funeral later that month, and we all knew that a very special person had passed from our ranks.

One of the things that John and I talked about during his last months of life was his desire for *Aerodynamics for Engineers* to continue to grow and evolve, even if he was not around to help with that task. I cannot help but think that he asked me to be his co-author for the fifth edition for this purpose. So, in spite of the fact that John is no longer with us, his spirit and excitement for learning will continue to live.

So, there were many goals for writing the sixth edition of *Aerodynamics for Engineers*: (1) to continue the legacy of Professor Bertin; (2) to rewrite many of the sections that provide readers with a motivation for studying aerodynamics in a more casual, enjoyable, and readable manner; (3) to update the technical innovations and advancements that have taken place in aerodynamics since the writing of the previous edition; and (4) to add aerodynamics concept boxes throughout the book to enhance the interest of readers.

To help achieve these goals I provided readers with the following new information: importance of aerodynamics to aircraft performance, a description of the airplane, the irrotational flow condition, applications of potential flow theory to aerodynamics, expanded descriptions of airfoil geometry and nomenclature, high lift military airfoils, the effect of taper ratio on wing efficiency, induced drag estimation, converging-diverging nozzles, shock/shock interactions, subsonic compressible transformations, additional compressibility corrections, critical Mach number, drag divergence Mach number, base drag, and the distinguishing characteristics of hypersonic flow. These new sections should greatly enhance the usability of the book.

In addition, there are numerous new figures containing updated information, as well as numerous, additional up-to-date references throughout the book. Finally, numerous new example problems have been added throughout the book to enhance the

learning of aerodynamics by the reader, and answers to selected problems have been added to help students know when they have done the problems correctly. Users of the fifth edition of the book will find that all material included in that edition is still included in the sixth edition, with the new material added throughout the book to bring a real-world flavor to the concepts being developed. I hope that readers will find the inclusion of all of this additional material helpful and informative.

Finally, no major revision of a book like *Aerodynamics for Engineers* can take place without the help of many people. I am especially indebted to everyone who aided in collecting new materials for the sixth edition. I want to especially thank Preston A. Henne and Robert van't Riet of McDonnell Douglas; Eli Reshotko of Case Western Reserve University; David W. Hall of DHC Engineering; Stuart Rogers of NASA Ames Research Center; David McDaniel of the University of Alabama, Birmingham; Hans Hornung of Caltech; Andreas Schütte and Martin Hepperle of DLR; Patrick Champigny of ONERA; Aaron Byerley of the U.S. Air Force Academy; John McMasters of The Boeing Company; and William H. Mason of Virginia Tech. In addition, I am very grateful for the excellent suggestions and comments made by the reviewers of the sixth edition: Roger L. Simpson of Virginia Tech, Tej R. Gupta of Embry-Riddle Aeronautical University, Serhat Hosder of Missouri University of Science and Technology, and Lisa Grega of The College of New Jersey. The editorial and production staff at Pearson has been outstanding in their support of this new edition: I greatly appreciate their efforts. I am also extremely grateful to the many students at the U.S. Air Force Academy who have pointed out errors that they found in the previous edition. I hope that everyone who reads this book will find it useful and educational.

WHAT'S NEW TO THIS EDITION?

- Aerodynamics concept boxes added throughout the book to bring real-world examples and applications to light as new material is being learned
- Chapter objectives to give readers a better understanding of the goal of each chapter and what concepts they should understand after reading through the chapter
- Significant re-writing of material and derivations from previous editions to improve clarity and usefulness
- Extra example problems to improve understanding of how to apply concepts to useful applications
- Significant new sections added on the topics of: importance of aerodynamics to aircraft performance, a description of the airplane, the irrotational flow condition, applications of potential flow theory to aerodynamics, expanded description of airfoil geometry and nomenclature, high lift military airfoils, the effect of taper ratio on wing efficiency, induced drag estimation, converging-diverging nozzles, shock/shock interactions, subsonic compressible transformations, additional compressibility corrections, critical Mach number, drag divergence Mach number, base drag, and the distinguishing characteristics of hypersonic flow
- Updated figures and photographs to help readers see concepts from real examples and on real aircraft
- Answers to selected problems

Enjoy your study of aerodynamics!

INSTRUCTORS RESOURCES

Resources to accompany the text are located at www.cambridge.org/bertin-cummings6e.

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