Preface

Within aerodynamics, the transonic Mach range is a much-studied topic among industrial and academic institutions. Many of today's airliners cruise at Mach numbers where both subsonic and supersonic flow exist. Terms such as *drag divergence*, *buffet*, and *transonic dip* are all associated with transonic flow conditions. Transonic aerodynamics has, to a large degree, dominated the exterior design of high-subsonic aircraft for the past 60 years. However, textbooks on compressible aerodynamics often focus on the supersonic Mach range and less on the phenomena in the transonic Mach regime. Therefore, a comprehensive course on transonic aerodynamics is seldom part of an aerospace engineering curriculum.

This discrepancy between the importance of transonic aerodynamics in practice and the lack of a comprehensive course on the subject is often explained by the complexity of the subject matter. Indeed, the governing equations that include all the relevant aerodynamic phenomena cannot be easily reduced to something equivalent to a thin airfoil theory or a lifting-line theory. Also, many correction factors such as the well-known Prandt-Glauert compressibility correction do not hold in the transonic regime. In order to predict the performance of a wing or wing section, one therefore often relies on computer programs that solve a numerical implementation of the governing equations of motion. But teaching students how to operate a piece of software is not the same as teaching students the physics of how and why certain phenomena occur when a body is subjected to transonic flow conditions. Therefore, this textbook was written to teach students about the nature of transonic flow and how it can be captured in mathematical equations.

This textbook serves as an introduction to the subject of transonic aerodynamics. In eight chapters we present a quantitative and qualitative assessment of subsonic, supersonic, and transonic flow about bodies in two and three dimensions. We have included relevant analytical analysis methods that allow students to practice with the subject matter. The book contains numerous examples and every chapter closes with a list of problems. Some subjects are treated more from a numerical perspective (e.g., shock and expansion theory), while others are discussed more from a qualitative point of view (e.g., shock-boundary-layer interaction). Where possible, numerical examples and methods have been included to enhance the understanding of each subject. The book contains 60 examples and more than 200 practice problems.

This textbook is intended primarily for senior undergraduate students or graduate students with prior knowledge in aerodynamics. Although we repeat the fundamental equations and flow characteristics in the beginning of the book, we do assume that the student has had a course on subsonic aerodynamics and is familiar with its fundamentals. Even though knowledge of transonic aerodynamics is important for many internal flow applications (e.g., turbo machinery, engine intakes, exhausts, etc.) the present textbook primarily focuses on external aerodynamics with limited applications to internal flows. Examples are targeted mainly toward wings and bodies exposed to a transonic flow field. Many of the examples reference *real* aircraft or wing components. Therefore, a strong connection is present between the content of this textbook and the subject of transonic aircraft design. To understand why a modern high-subsonic aircraft is designed the way it is, requires one to understand the subject matter of this textbook.

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Delft, The Netherlands, 2014 Roelof Vos
Lawrence, KS, USA Saeed Farokhi

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