

# PRELIMINARIES

The dawn of the twentieth century marked the beginning of the numerical solution of differential equations in mathematical physics and engineering. Numerical solutions were carried out by hand and using desk calculators for the first half of the twentieth century, then by digital computers for the later half of the century. In Section 1.1, a brief summary of the history of computational fluid dynamics (CFD) will be given, along with the organization of text.

Before we proceed with details of CFD, simple examples are presented for the beginner, demonstrating how to solve a simple differential equation numerically by hand calculations (Sections 1.2 through 1.7). Basic concepts of finite difference methods (FDM), finite element methods (FEM), and finite volume methods (FVM) are easily understood by these examples, laying a foundation or providing a motivation for further explorations. Even the undergraduate student may be brought to an adequate preparation for advanced studies toward CFD. This is the main purpose of Preliminaries.

Furthermore, in Preliminaries, we review the basic forms of partial differential equations and some of the governing equations in fluid dynamics (Sections 2.1 and 2.2). These include nonconservation and conservation forms of the Navier-Stokes system of equations as derived from the first law of thermodynamics and are expressed in terms of the control volume/surface integral equations, which represent various physical phenomena such as inviscid/viscous, compressible/incompressible, subsonic/supersonic flows, and so on.

Typical boundary conditions are briefly summarized, with reference to hyperbolic, parabolic, and elliptic equations (Section 2.3). Examples of Dirichlet, Neumann, and Cauchy (Robin) boundary conditions are also examined, with additional and more detailed boundary conditions to be discussed later in the book.

