# *SECTION 1. NUMERICAL SIMULATION OF TWO-DIMENSIONAL PROBLEMS OF EXTERNAL AERODYNAMICS*

The computational aerodynamics methods are being developed actively nowadays and are being used successfully to solve various problems of external and internal aerodynamics. Many different approaches for numerical simulation of the viscous gas dynamics equations have been created within the framework of this direction. Among others is a method based on the implicit Beam-Warming finite-difference scheme (Beam and Warming, 1978), and its further modification (Steger, 1978; Hollanders and Devezeaux de Lavergne, 1987).

Newton approach to implicit finite difference schemes with subsequent linearization and solution of a system of algebraic equations is considered to be the most complete mathematically (Egorov and Zaitsev, 1991). This approach has been developed for numerical integration of unsteady two-dimensional Navier-Stokes equations (Bashkin, et al., 1993) and Reynolds equations (Bashkin, et al., 2000a) under Boussinesq assumption about Reynolds stresses using two-parameter turbulence model (Huang and Coakley, 1993). This approach has been implemented numerically in a code that can be run on a personal computer. It has been used successfully for solution of a number of supersonic problems of external and internal aerodynamics: a circular cylinder, a sphere, flat and axisymmetric channels (Bashkin, et al., 1998), a basic flat hypersonic air inlet (Bashkin, et al., 1996, 1997ab, 1999ab, 2001).

This approach is described in the first chapter as applied to two-dimensional perfect gas flow and some results of parametric computations for supersonic separated flow are discussed. The results of numerical simulation of a number of two-dimensional problems of external aerodynamics concerning transonic, supersonic, and hypersonic perfect gas flow over flat and axisymmetric bodies are analyzed in the next chapters.