Preface

Laminar and turbulent flows are two common states of viscous fluids existing in natural environments, which have different aerodynamic and thermal characteristics. The boundary layer transition from laminar to turbulent flow is in nature a turbulence problem, one of the unsolved masteries in fluid dynamics today. Understanding the mechanism of boundary layer transition phenomena and applying it to benefit engineering designs have been great interests of scientists and engineers over the past century. With the advent of modern high performance computers as well as advanced computational modeling and simulation techniques, there has been significant progress towards an improved understanding of this fundamental fluid phenomenon. Numerical predictions of boundary layer transitions have evolved from earlier linear stability methods to more prevailing statistical modeling methods, and recently to Large Eddy Simulation (LES) or Direct Numerical Simulations (DNS).

This book provides a detailed description of numerical methods and validation processes for predicting transitional flows based on the Langtry–Menter Local Correlation-based Transition Model (LCTM), integrated with the one-equation Spalart–Allmaras (S–A) and two-equation Shear Stress Transport (SST) turbulence models. A comparative study is presented to combine the respective merits of the two coupling methods in the context of predicting the boundary layer transition phenomena from fundamental benchmark flows to realistic helicopter and tiltrotor blades. A method to correct premature flow separation is introduced in the book to address a numerical modeling issue pertinent to three-dimensional rotor aerodynamic predictions. A practical guideline is suggested for obtaining engineering solutions for realistic helicopter or tiltrotor performance using moderate computing resources.

This book will be of interest to industrial practitioners working in aerodynamic design and analysis of fixed wing or rotary wing aircraft. It will also offer advanced reading material for university graduate students in the research areas of Computational Fluid Dynamics (CFD), turbulence and transition modeling, and related fields. The structure of this book is organized as follows:

In Chap. 1, general information about the viscous fluid transition phenomena is introduced, including various transition modes and underlying mechanisms. An overview of selective predicting methods for fluid transitions is provided in Chap. 2. In Chap. 3, the Langtry–Menter's correlation-based transition model is described in detail including integration with the Spalart–Allmaras (S–A) and Menter's Shear Stress Transport (SST) turbulence models. Chapter 4 provides validations of the models in two-dimensional benchmark viscous flows, and Chap. 5 presents applications for three-dimensional realistic helicopter and tiltrotor blade performance predictions.

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