Preface

Rotating beams are important mathematical models for structures such as helicopter rotor blades, wind turbine rotor blades, propellers, turbine blades and robotic manipulators. Therefore, the modeling and analysis of rotating beams is an important practical problem. The natural frequencies of the rotating beam should be kept away from multiples of the rotor speed. Therefore, accurate frequency prediction is important. Control of rotating beams requires the development of low-order models. This motivates the development of efficient mathematical models. Since the rotating beam equation does not have a simple exact solution, approximate methods such as Rayleigh–Ritz, Galerkin, and the finite element methods are widely used for the vibration analysis of rotating beams. This book provides an introduction to the finite element for rotating beams. A background on the Rayleigh–Ritz and Galerkin method is also provided.

The first chapter gives a detailed introduction to the rotating beam equation and illustrates the Rayleigh–Ritz, Galerkin, and finite element methods for its solution. Several example problems are given to illustrate the methods. A MATLAB finite element code for the rotating beam is also provided. The following chapters give adaptations of the basis functions which can accelerate the convergence of rotating beam finite elements, thus allowing for efficient low-order models. Some of these basis functions are based on analogies between the piano string and rotating Euler–Bernoulli and between the violin string and rotating Timoshenko beams. A major theme here is to choose finite element interpolation functions which are closer to the problem physics.

This book should be useful to engineers, graduate students and researchers working on rotating beam problems. It is also useful for people in the area of computational mechanics and applied mathematics.

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