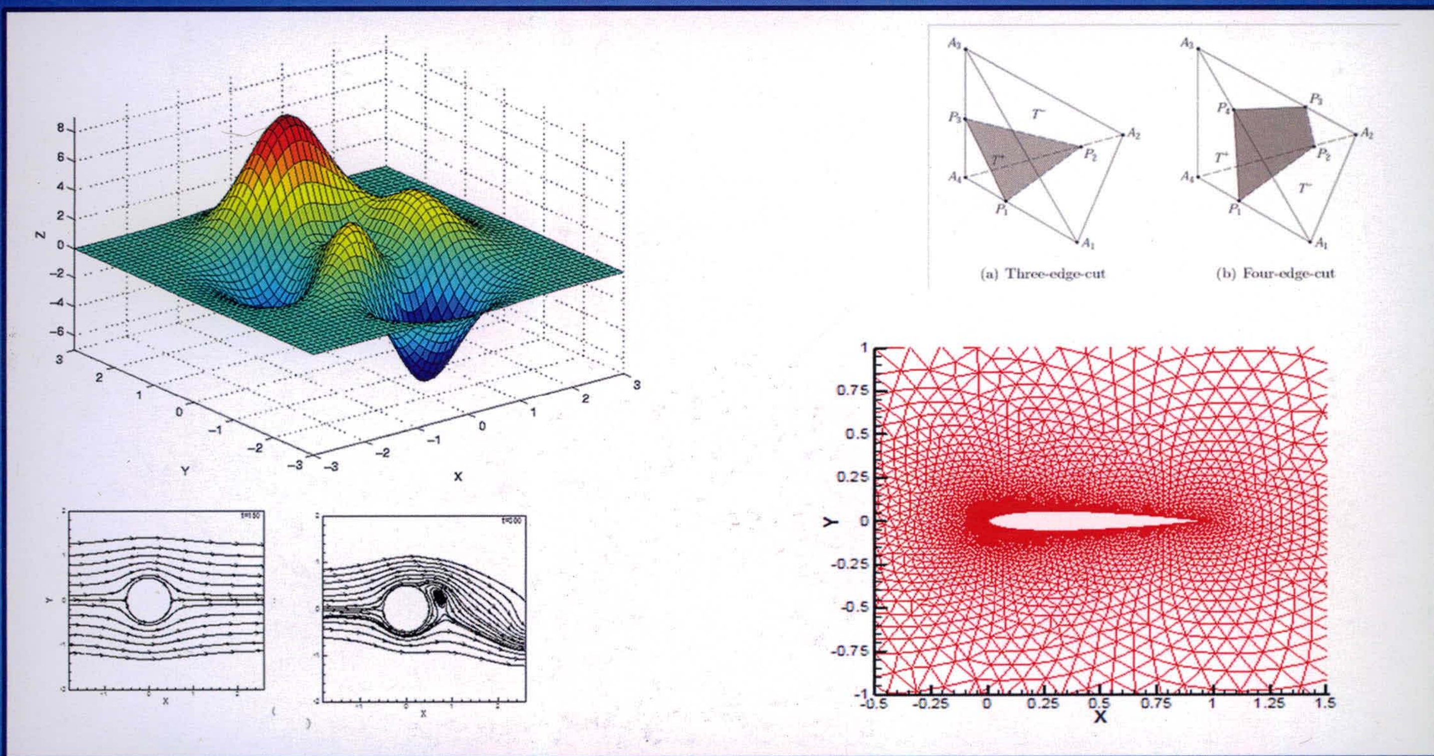
ADVANCED NUMERICAL TECHNIQUES IN ENGINEERING and SCIENCE



Editors
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CHAPTER 3

Comparison of a Pseudo-spectral Method and an Implicit Finite Difference Scheme for the Solution of a Nonlinear Dynamic Problem

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ABSTRACT

The nonlinear dynamics of thin film flow on a solid plane is represented by the so called 'equation of evolution (EOE)' – a nonlinear fourth order partial differential equation. The extent of nonlinearity and stiffness of the EOE depends upon the nature of the different types of intermolecular and external forces considered in the body force term of the equation of motion. Further, a thin film subjected to various physico-chemical effects, such as thermocapillarity, marangoni flow, heat and mass transfer, and chemical reaction at the film interface also decide the extent of nonlinearity of the EOE. However, for the purpose of illustrating the numerical algorithm, we consider a general model of an ultrathin film of Newtonian liquid on a plane solid substrate subjected to apolar van der Waals and polar intermolecular forces expressed in terms of the second derivative of free energy, ϕ in the governing equation. The EOE was solved numerically for periodic boundary conditions as an initial value problem when the free surface of the film was initially subjected to a sinusoidal wave perturbation. Two different classes of numerical methods: a pseudo-spectral and an implicit finite difference discretization are used. The numerical results from the two techniques are compared. It is shown that the Fourier collocation (FC), a pseudo-spectral method is easy to implement for nonlinear problems with periodic boundary conditions. The computation time required