Finite elements analysis (FEM) is one of the most powerful tools for the numerical simulation of complex industrial problems. Still new formulations and discretization schemes have to be developed that account for the needs of advanced applications in engineering.

The book is intended for students and engineers who want to develop new finite element formulations, especially for nonlinear problems. The derivations of the finite element matrices and vectors needed for an efficient treatment of nonlinear applications within a finite element environment can become extremely complex and error-prone. Due to the power of symbolic computations it is nowadays possible to automatically generate efficient and highly compressed code for linear and nonlinear problems. By this, tedious hand calculations can be avoided leading to more accurate implementations and huge time savings in the development phase, e.g., of new finite elements or material models.

Based on the symbolic system AceGen fast and reliable code can be created with a minimum of effort and immediately be tested and verified by using the associated finite element program AceFEM. AceGen is a package within Mathematica and produces source code for different finite element environments. The use of AceGen is described within this book for applications in solid mechanics. For that the basic equations of continuum mechanics are summarized and the input for the symbolic systems is added in order to provide a guide to apply AceGen for nonlinear problems of three-dimensional solids such as hyperelasticity, finite deformation plasticity, and sensitivity analysis. In addition, element formulations for structural elements like nonlinear truss-, beam-, and shell structures will be developed.

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