



Finite Element Methods and Navier-Stokes Equations (Mathematics and Its Applications)

C. Cuvelier, August Segal, A.A. van Steenhoven

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In present-day technology the engineer is faced with complicated problems which can be solved only by advanced numerical methods using digital computers. He should have mathematical models at his disposal in order to simulate the behavior of physical systems. In many cases, including problems in physics, mechanics, chemistry, biology, civil engineering, electrodynamics, solid mechanics, space engineering, petroleum engineering, weather-forecasting, mass transport, multiphase flow and, last but not least, hydrodynamics, such a physical system can be described mathematically by one or more partial differential equations. Some of these problems require extreme accuracy, while for other problems only the qualitative behavior of the solution need to be studied. The finite element method (FEM) is one of the most commonly used methods for solving partial differential equations (PDEs). It makes use of the computer and is very general in the sense that it can be applied to both steady-state and transient, linear and nonlinear problems in geometries of arbitrary space dimension. The FEM is in fact a method which transforms a PDE into a system of linear (algebraic) equations. The following aspects may be identified in the study of a physical phenomenon: (i) engineering-mathematical sciences to formulate the problem correctly in terms of PDEs (ii) numerical methods to construct and to solve the system of algebraic equations; applied numerical functional analysis to give error estimates and convergence proofs (iii) informatics and programming to perform the calculations efficiently on the computer.

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