

dr hab. inż. Jan Jaśkowiec

Schematy całkowania wysokiego rzędu dla przestrzennych elementów skończonych

High order integration schemes for spatial finite elements

The new approach for constructing high-order numerical integration schemes for 3D finite elements will be presented. The construction of cubature rules is a challenging problem, which requires the solution of strongly nonlinear algebraic (moment) equations with side conditions given by affine inequality constraints. The new robust algorithm is based on a sequence of three modified Newton procedures to solve the constrained minimization problem. The monomial basis functions are adopted in the algorithm and a preconditioner is used to ensure a well-conditioned nonlinear system of equations. The algorithm permits the computation of integration rules with points that are in the interior of the domain and with positive weights. The algorithm has been applied to various 3D finite elements: cube, wedge, pyramid, however the main attention in the presentation is devoted to tetrahedral element, which is the most popular one in computational methods. The new numerical integration rules up to $p=20$ have been computed for the tetrahedron using multi-precision arithmetic. Numerical tests that verify the polynomial-precision of the cubature rules have been conducted using double-precision arithmetic.