Department of Mathematical Sciences Colloquium

Martin Zítka

Department of Mathematical Sciences, UTEP

On the role of orthonormality in hp-FEM

The *hp*-FEM is a sophisticated version of the Finite element method (FEM) which uses a simultaneous variation of both the size and polynomial degree of elements to maximize the convergence rates. Typically, stiffness matrices resulting from the *hp*-FEM are much smaller compared to standard FEM, which makes the *hp*-FEM faster and less memory-consuming. However, at the same time it is well known that the condition number of these stiffness matrices, and consequently the performance of iterative solvers, depends strongly on the representation of the polynomial spaces on finite elements. When the hierarchic shape functions are chosen in a wrong way, iterative solvers may fail to converge.

In this talk we focus on linear symmetric elliptic PDEs and discuss several new aspects related to the design of optimal shape functions. We begin with introducing shape functions which are partially orthonormal under a suitable inner product on the reference domain, and compare them numerically to the currently most popular sets of hierarchic shape functions. At the same time we show that no optimality can be reached when staying on the reference domain, and we introduce shape functions which are partially orthonormal in physical mesh elements. We develop shape functions which automatically eliminate all internal degrees of freedom (DOF) from the stiffness matrix. The relation of this approach to the so-called *static condensation of internal DOF* is discussed. Finally, we discuss a new idea of generalized eigenfunctions which are capable of eliminating internal DOF from both the stiffness and mass matrices simultaneously.

Friday, September 9, 2005 at 3 pm. in Bell Hall 143
The University of Texas at El Paso

Refreshments will be served in front of the colloquium room, 15 minutes before the start of the colloquium.

For further information, please contact Dr. Pavel Šolín, Bell Hall 220. Phone: (915) 747-6770, email: `solin@utep.edu`.