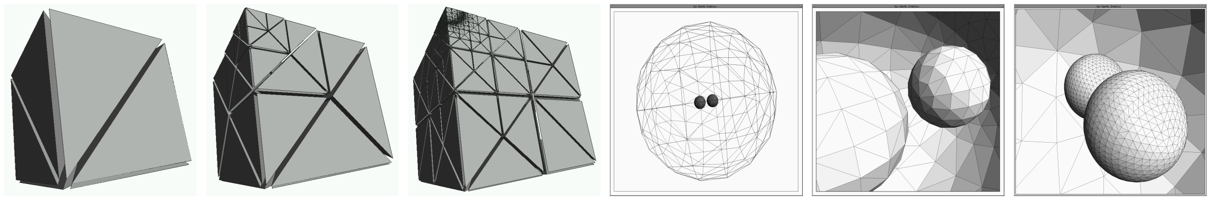
Math 292B (Applied Mathematics), 1998 Winter Quarter

Course Topic: Finite Element Methods for PDEs II



Instructor:	Michael Holst, Assistant Professor, UCI Department of Mathematics
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Lecture:	PST 100, 4:00pm-4:50pm, MWF (UCI course number 44905)
Lab:	PS 390 (CAMLAB), 5:00pm-5:50pm, MWF
Texts:	*Computat. Diff. Eqn.* [16], Eriksson, Estep, Hansbo, and Johnson.
	Finite Elements [6], Braess.

Math 292B is the second quarter of a three-quarter course on finite element techniques for the numerical solution of partial differential equations. Following the approach taken in the first quarter, we will use the lectures and theoretical homeworks to build a solid foundation in numerical analysis, partial differential equations, and finite element approximation theory. Using programming assignments, we will explore data structures, computational geometry algorithms, iterative methods, and other finite element implementation issues.

There are no prerequisites for 292B beyond the ability to understand and construct analysis (ϵ-δ) arguments (e.g., Math 140A-B-C or equivalent background), minimal background in linear algebra (e.g., Math 3A or Math 6C), and some experience with one programming language (e.g., MATLAB or C). The course will be self-contained, and structured so that students interested in either the analysis or the engineering aspects of the finite element method can both do well in the course. Note that 292A is NOT a prerequisite for 292B.

We studied methods for elliptic (Poisson-like) equations the first quarter, and we will move on to study parabolic (heat-like) equations this quarter. We will first spend some time on iterative methods for algebraic systems, due to their importance in the numerical treatment of elliptic and parabolic equations. Picking up where the first quarter left off, everyone will be given a working finite element implementation (which we developed last quarter for a general class of nonlinear elliptic equations). Our programming assignments will involve implementing better iterative methods, and extending the implementation to nonlinear parabolic equations. The lectures will cover the following topics:

- Iterative methods and complexity: classical (stationary) methods
- Conjugate gradient methods and more general Krylov methods
- Multigrid methods and domain decomposition methods
- Abstract additive and multiplicative Schwarz methods and theory
- Parabolic equations and the structure of solutions
- Petrov-Galerkin methods for parabolic equations
- Finite element error analysis in the parabolic case
- Adaptive error control for elliptic and parabolic equations

In the third quarter (292C), we will study several advanced topics in finite elements, such as methods for hyperbolic (wave-like) equations, methods for nonlinear problems with folding and bifurcating solutions, and general multilevel finite element approximatinon theory (following the Teubner monograph of P. Oswald).