

**MECHANICAL ENGINEERING DEPARTMENT
ME 8773-8774**

**On Least-Squares Finite Element Formulations
With Applications to Problems in Fluid and Solid Mechanics**

by

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Wednesday, November 19, 2008

3:15 p.m. — Refreshments before the seminar

3:30 p.m. — Graduate Seminar

Room 1130 Mechanical Engineering

ABSTRACT — In this lecture, a computational methodology based on least-squares variational principles and the finite element method is discussed for the numerical solution of the Navier-Stokes equations governing viscous incompressible fluid flows and equations governing shear deformation theories of plates and shells. The use of least-squares principles leads to variationally unconstrained minimization problems, where compatibility conditions between approximation spaces – such as inf-sup conditions – never arise. Furthermore, the resulting linear algebraic problem will always have a symmetric positive definite (SPD) coefficient matrix, allowing the use of robust and fast preconditioned conjugate gradient methods for its solution. In the context of viscous incompressible flows, least-squares based formulations offer substantial improvements over the (traditional) weak form Galerkin finite element models – where the finite element spaces for velocities and pressure must satisfy an inf-sup compatibility condition and one must deal with an un-symmetric and indefinite coefficient matrix. In contrast, least-squares formulations circumvent the inf-sup condition, allowing equal-order interpolation of velocities and pressure, and result (after suitable linearization) in linear algebraic systems with a SPD coefficient matrix. In this lecture, the basic theory of least-squares finite element formulations of the Navier-Stokes equations governing viscous incompressible flows and shear deformable theories of beams, and plate and shell structures will be presented, and their application through some benchmark problems will be discussed.

BIO — **Dr. J. N. Reddy** is a Distinguished Professor and inaugural holder of the Oscar S. Wyatt Endowed Chair in Mechanical Engineering at Texas A&M University, College Station, TX. Dr. Reddy is the author of over 350 journal papers and 15 textbooks on theoretical and finite-element analysis of problems in solid and structural mechanics (plates and shells), composite materials, computational fluid dynamics, numerical heat transfer, and applied mathematics. Dr. Reddy is the recipient of the 1984 *Water L. Huber Civil Engineering Research Prize* of the American Society of Civil Engineers (ASCE), the 1985 *Alumni Research Award* at Virginia Polytechnic Institute, and 1992 *Worcester Reed Warner Medal* and 1995 *Charles Russ Richards Memorial Award* of the American Society of Mechanical Engineers (ASME). He received German Academic Exchange (DAAD) and von Humboldt Foundation (Germany) research awards. Most recently, he received the 1977 *Melvin R. Lohmann Medal* from Oklahoma State University's College of Engineering, Architecture and Technology, the 1997 *Archie Higdon Distinguished Educator Award* from the Mechanics Division of the American Society of Engineering Education, the 1998 *Nathan M. Newmark Medal* from the American Society of Civil Engineers, the 2000 *Technomic Award for Composites* from the American Society of Composite Materials, the 2000 *Faculty Distinguished Achievement Award for Research* from Texas A&M University, the 2003 *Texas A&M Bush Excellence Award for Faculty in International Research* award, and the 2003 *Computational Solid Mechanics* award from USACM.

Professor Reddy is a fellow of the American Academy of Mechanics (AAM), AIAA, ASCE, ASME, ASC, IACM, USACM, ASI, and ASCM. He has delivered over seventy plenary, keynote, or general lectures at national and international conferences. Dr. Reddy serves on the editorial boards of about two-dozen journals. He is the Editor-in-Chief of *Mechanics of Advanced Materials and Structures*, and serves as one of the Chief Editors of *International Journal of Computational Engineering Science* and *International Journal of Structural Stability and Dynamics*. **A more complete resume with links to journal papers can be found at <http://authors.isihighlycited.com/> or <http://www.tamu.edu/acml>.**

Informal Faculty Luncheon: Wednesday, November 19, 2008, 12:00 noon. Meet in Room 1100 ME and walk to lunch with other faculty. Prof. J. N. Reddy will be able to attend. Host: Prof. Kumar Tamma