A Short Course on

THE FINITE ELEMENT METHOD

Bogota, COLOMBIA

Course Instructor/Lecturer

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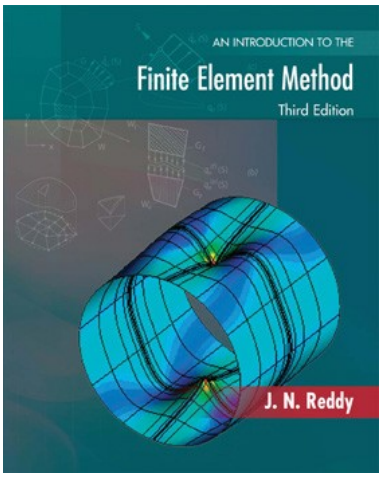

Course Title:

The Finite Element Method *with Applications in Heat Transfer, Fluid Mechanics and Solid and Structural Mechanics*

Dates (tentative): August 11 and 12, 2009

Coordinator(s): Gerardo Gordillo
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ABOUT THE COURSE

Background

The Finite Element Method (FEM) is a numerical and computer-based technique of solving a variety of practical engineering problems that arise in different fields. It is recognized by developers and users as one of the most powerful numerical analysis tools ever devised to analyze complex problems of engineering. As applied to solid and structural problems, the finite element method is the leading technique for analyzing the behavior of structures when subjected to a variety of loads. The loads may be static or dynamic, and the structural responses can be linear or non-linear, with varying degrees of complexity. The underlying theory of the method is now well established, with many books and courses providing adequate explanations of the theory.

Course Objectives

The major problem facing the analyst contemplating the use of the technique lies in acquiring appropriate knowledge to provide assurance that the finite element model produced gives a reasonably reliable representation of the "real life" system being analyzed. The present course is designed to bridge the gap between the theoretical finite element knowledge and its industrial applications by providing sufficient insights into the relationship between the physical data (e.g., loads,

boundary conditions, constitutive behavior, etc) and the finite element model. The instructor will share practical applications and their experiences to address some of the issues such as element selection, mesh design, boundary conditions, convergence, and response characteristics. The course will also involve interactive participation to discuss problem solving using finite element method.

This course is intended to provide engineers working in aerospace, automotive, civil, and mechanical engineering disciplines as well as numerical analysts and materials scientists with the theory and applications of the finite element method to problems from solid and structural mechanics, fluid mechanics, and heat transfer. At the end of the course one would have acquired knowledge of finite-element analysis of many typical problems of engineering.

Benefits of Attending the Course

Persons who have attended the course and followed the material should benefit in strengthening their background in the following areas:

• A strong understanding of the formulative steps involved in the finite element model development of the equations of solid and structural mechanics and certain heat transfer and fluid flow problems.

• Generation of finite element data (e.g., selection of elements and mesh, computation of nodal forces, imposition of boundary conditions, post-computation of stresses and strains, etc.), exploitation of problem symmetries, and interpretation and evaluation of the results.

Course Materials

A copy of the overheads used in the presentation of the course will be provided as a part of the course material. The introductory finite element book by JN Reddy may purchased from local vendors. The reference information on the book is: Reddy, J. N., *An Introduction to the Finite Element Method*, Third Edition, McGraw-Hill, New York, 2006.

COURSE CONTENTS (actual coverage and sequence may differ depending on the participants background)

The basic concepts in FEM – one-dimensional problems

- Axial deformations of a bar
- Strong and weak forms
- Essential vs. natural boundary conditions
- Integral statements (Principle of the minimum potential energy)
- Methods of approximations (Ritz & Galerkin methods)
- Accuracy – error measures
- Finite element approximation functions (linear, quadratic, and cubic elements)
- Assembly of element equations
- Illustrative examples and discussion of results in light of physical response

Extension of the concepts to higher-order and two-dimensional problems

- Flexure of beams (Euler-Bernoulli and Timoshenko) beams
- Membrane and heat transfer-like problems in 2D
- Elements types (triangular and quadrilateral elements)
- Axisymmetric problems

Eigenvalue and Time-Depenedent problems

- Free vibration of elastic systems (natural frequencies, modal response, etc)
- Transient Analysis

Numerical/computational issues

- Subparametric, isoparametric, and superparametric formulations
- Numerical integration
- General modeling considerations

Solid and Structural Problems

- Governing equations of plane elasticity problems
- Elements types (triangular and quadrilateral elements)
- Bending of thin and thick elastic plates
- Examples

Introduction to viscous flow problems

- Governing equations (Stokes Equations)
- Mixed finite element model (2D)
- Penalty finite element model (2D)
- Numerical examples

About the Course Instructor: J. N. Reddy

http://authors.isihighlycited.com/ and http://www.tamu.edu/acml

Dr. 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, Texas. Dr. Reddy is the author of over 375 journal papers and 15 text books on theoretical formulations 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. The books authored by Dr. Reddy include: An Introduction to Continuum Mechanics (Cambridge University Press, 2008); An Introduction to Nonlinear Finite Element Analysis, Oxford University Press, 2004; An Introduction to the Finite Element Method, McGraw-Hill, 1984 (3rd ed., 2006); Energy Principles and Variational Methods in Applied Mechanics, John Wiley, I984 (2nd ed., 2002); Applied Functional Analysis and Variational Methods in Engineering, McGraw-Hill, 1986; Mechanics of Laminated Composite Plates and Shells: Theory and Analysis, CRC Press, 1997 (2nd ed., 2004); and Theory and Analysis of Elastic Plates and Shells, Taylor & Francis, 1999 (2nd edition in preparation). As a result of his extensive publications of archival journal papers and books on a wide range of topics in applied sciences and engineering, Dr. Reddy is one of the selective few researchers in engineering around world who are recognized by *ISI Highly Cited Researchers* with over 10,000 citations and *H-index* of over 40.