MECHANICAL ENGINEERING & MATHEMATICAL SCIENCES DEPARTMENTS

Spring Semester 2008-2009 (082)

ME 501 *:* NUMERICAL METHODS IN MECHANICAL ENGINEERING

MATH *574 :* NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EOUATIONS

***Catalog Data*::** ME 501: Numerical Methods in Mechanical Engineering.
MATH *574*: Numerical Methods for Partial Differential Equations.

Credit 3. Concepts of consistency, stability and convergence of numerical schemes. Initial and boundary value problems for ordinary differential equations. Various finite difference and finite element methods and their applications to fundamental partial differential equations in engineering and applied sciences. Case studies selected from computational fluid mechanics, solid mechanics, structural analysis, and plasma dynamics.
Prerequisite: SE 301.

Textbook/ References:

1) Smith, G.D. *NUMERICAL SOLUTION OF PARTIAL DIF-FERENTIAL EQUATIONS.*
2) Segerlind, Larry J., *APPLIED FINITE ELEMENT ANALYSIS*.
3) Lapidus and Pinder. *NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS IN SCIENCE AND ENGINEERING.* John Wiley & Sons, 1982.
4) Reddy, J.N. *AN INTRODUCTION TO THE FINITE ELEMENT METHOD,* McGraw-Hill Book Company, 1984.
5) Carnahan et al. *APPLIED NUMERICAL METHODS.*
6) Patankar, S.V. *NUMERICAL HEAT TRANSFER AND FLUID FLUID.*
7) Hoffman, J.D.*, NUMERICAL METHODS FOR RNGINEERS AND SCIENTISTS, 1992, McGraw-Hill, Inc.*
8) Versteeg, H. K. and Malalasekera, AN INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS: THE FINITE VOLUME METHOD, 1995, Longman Scientific & Technical.

Instructors Dr. Haitham Bahaidarah, Assistance Professor of Mech. Eng. Dept., Tel 1747.
Dr.Kassem Mustaph, Assistance Professor, Math. Sciences Dept, Tel 7199.

Goals The course provides the essential elements of all the numerical methods currently used extensively in the solution of partial differential equations encountered in Engineering.

Prerequisites by topic:

1) Solution of systems of linear and non-linear algebraic equations.
2) Numerical differentiation and integration.
3) Interpolation, extrapolation and approximation.
4) Numerical solution of ordinary differential equations.

Topics

1) Introduction and fundamental concepts. (3 Classes)
2) Basic concepts of finite differences. (3 Classes)
3) Finite-difference solutions to parabolic partial differential equations. (5 Classes)
4) Consistency, convergence, and stability. (2 Classes)
5) Elliptic partial differential equations. (3 Classes)
6) Hyperbolic partial differential equations. (2 Classes)
7) Control volume approach and applications to some relevant problems (6 Classes)
8) The finite element method for time independent problems. (10 Classes)
9) The finite element method for time dependent problems. (4 Classes)
10) The finite element method for nonlinear problems. (4 Classes)
11) Tests. (3 Classes)

Computer usage:

Each student must write and run computer programs to solve problem application to the solution of parabolic, elliptic, and hyperbolic partial differential equations.

Projects:

Two projects that include the application of the above topics to engineering problems are assigned to each student. Reports are required.

Laboratory Projects*:*
(including major items of equipment and instrumentation used)

None.

Grading:

The distribution of grade is as follows:

Class test (finite differences)	*10%*
Class work (quiz, home works and project) (finite differences)	*15%*
Major 1 (Finite differences)	*10%*
Final Exam (finite differences, comprehensive)	*15%*
Homeworks (Finite elements)	*20%*
Final Exam (Finite elements)	*30%*
Total	*100%*