CE 371 NUMERICAL METHODS IN CIVIL ENGINEERING

Elective Course

Fall 2008

Instructor: *Name:* Cem Avcı

Office Hours: M 34, W 34

Office No.: M 3010

Course Data: Hours: M 56, W 5

Room: M 2170, M 3120

Course Description (Catalog):

CE 371 Numerical Methods in Civil Engineering **(3+0+0)3**

Use of numerical techniques to investigate case studies in civil engineering topics including hydraulics, geotechnics and structures. Interpolation and numerical integration techniques; numerical solutions to ordinary differential equations using Runge-Kutta and multistep techniques; application of finite difference techniques to partial differential equations using parabolic and elliptic equations; convergence and error analysis, development and application of computer programs to case studies derived from civil engineering practices.

Course Objectives (Learning Outcomes):

To introduce the principles of numerical techniques to junior level civil engineering students.

To review and implement the basic principles of interpolation and polynomial approximation, numerical integration, solving simple ordinary differential equations and partial differential equations.

Textbook:

Burden, R.L. and Faires, J.D., **"Numerical Analysis"**, Brooks/Cole, USA

Reference Books:

Ames,W.F. ,**"Numerical Methods for Partial Differential Equations"**, Academic Press, New York, 1977.

Carnahan, B., Luther, H.A. and Wilkes, J.O., **"Applied Numerical Methods"**, John Wiley and Sons, 1969.

Curricular Context

This elective course provides the foundation for the implementation of the numerical techniques.

Laboratory and Computer Usage:

Fortran, C, Matlab, MS Excel or related computer programs for numerical computations.

Class Policies:

Homework: Homework questions to be assigned from each chapter. 75% of the course grade.

Final project comprising 25% of the total grade.

Contribution of the Course to Program Outcomes:

(a) An ability to apply knowledge of mathematics, science and engineering

(e) An ability to identify, formulate and solve engineering problems

Course Assessment:

The course will be assessed on the basis of the accomplishments regarding the course objectives and the contributions to the program outcomes. The evaluation will consist mainly of the responses from the students, who will provide their comments to various course related questions in the final week of the semester.

WEEK	Topics	Objectives	Reading Assignments
1	Introduction Solutions of Equations in One Variable	Roots of equations frequently occur in the area of engineering design. Principles of bisection methods, single fixed-point iteration, Newton-Rapson method and Secant Method are discussed.	Ch 2
2	Interpolation and Polynomial Approximation	Estimation of points between discrete values given as data points. Basic approach is to fit a curve that pass directly between each of the data points. Review Lagrange interpolating polynomials, spline interpolation and Newton's divided difference interpolating polynomials.	Ch 3
3	Numerical Differentation	Review methods for estimating values of the differential of functions defined at discrete points	Ch 4
4	Numerical Integration	Review methods for estimating values of the integral of functions defined at discrete points	Ch 4
5	Initial Value Problems for Ordinary Differential Equations	Develop capability to solve ordinary differential equations with initial value problems. In addition understanding the assessment of reliability of the answers. Methods used include Euler's method, Runge-Kutta method, system of equations	Ch 5
6	Initial Value Problems for Ordinary Differential Equations	Develop capability to solve ordinary differential equations with initial value problems. In addition understanding the assessment of reliability of the answers. Methods used include Euler's method, Runge-Kutta method, system of equations	Ch 5
7	Boundary Value Problems for Ordinary Differential Equations	Develop capability to solve ordinary differential equations with boundary value problems. In addition understanding the assessment of reliability of the answers. Methods used include Shooting Method, Finite Difference method, Power Method	Ch 11
8	Boundary Value Problems for Ordinary Differential Equations	Develop capability to solve ordinary differential equations with boundary value problems. In addition understand the assessment of reliability of the answers. Methods used include Shooting Method, Finite Difference method, Power Method	Ch 11
9	Numerical solutions to Partial Differential Equations	Develop finite difference algorithm techniques for elliptic, parabolic and hyperbolic partial differential equations. Understand iterative techniques, explicit and implicit techniques, ADI methods. In addition understand the assessment of reliability of the answers	Ch 12
10	Numerical solutions to Partial Differential Equations	Develop finite difference algorithm techniques for elliptic, parabolic and hyperbolic partial differential equations. Understand iterative techniques, explicit and implicit techniques, ADI methods. In addition understand the assessment of reliability of the answers	Ch 12
11	Numerical solutions to Partial Differential Equations	Develop finite difference algorithm techniques for elliptic, parabolic and hyperbolic partial differential equations. Understand iterative techniques, explicit and implicit techniques, ADI methods. In addition understand the assessment of reliability of the answers	Ch 12
12	Approximation Theory	Develop principles of least-squares, multiple linear, nonlinear regression	Ch 8
13	Case Studies	Present case studies of numerical methods used in research as well as engineering applications	