ME 400/500 Fall 2013

Numerical methods/techniques in Mechanical Engineering

Prerequisites: Math 316
Instructor: Dr. Juan. C. Heinrich, heinrich@unm.edu, Room 430
    Office Hours: by appointment
Grader: Vahid Hatamipour, hatami@unm.edu , Room ME 421
Schedule, room: M-W 9:00-10:15, ME 310

Course Objectives:

The processes involved in engineering design invariably lead to quantification in order to initiate design construction. This invariably requires the evaluation of complex functions, the interpolation of data, the solution of equations, the production of graphics etc. All of which must be accomplished numerically. In order to do this effectively we must have knowledge of how computers function, how numerical calculations are performed, what are the most efficient algorithms and, most important, what are the errors associated with the calculations. We also must have an almost obsessive dose of mistrust, numerical algorithms do not always do what they are supposed to do and errors can be introduced at any and all steps of the process that will render the solutions useless. This can only be avoided by having a thorough understanding of the calculation techniques and their implementation together with a careful assessment of each and every step leading to the final results.

In this course we look at problems commonly encountered in engineering and learn about the thought process and techniques needed to find numerical solutions. We will examine the errors associated with the solutions and use physically based problems to illustrate the application of the numerical methods.

Knowledge of a programming language or system (C++, Fortran 90, MATLAB, etc.) is absolutely essential; in this course we will be doing numerical calculations.
Homework must be turned in in a timely manner; late HW will be significantly penalized and in no case will be accepted later than one week from the due date.

Course assessment:

1. Homework   30%
2. First exam, Wednesday September 18   20%
3. Second exam, Wednesday November 6   20%
4. Final Exam   30%

Textbook:

"Elementary Numerical Analysis, 3d edition" by K. Atkinson and W. Han, Wiley 2004.

References:

1. C.F.Gerald and P.O. Wheatley, "Applied Numerical Analysis, 6th edition" Addison-Wesley, 1999
2. W. H. Press, S. A. Teukolsky, W. T. Vettering and B. P. Flannery, "Numerical Recipes in Fortran, 2d edition", Cambridge University Press 1992
3. E. Isaacson and H. B. Keller, "Analysis of Numerical Methods", Wiley1966
4. S. J. Chapman, "Fortran 90/95 for scientists and engineers", McGraw-Hill 1998
5. O. Axelsson, "Iterative Solution Methods", Cambridge University Press 1996
6. J. M. Ortega and W. C. Rheinboldt, "Iterative Solution of Non-Linear Equations in Several Variables", Academic Press 1970
7. S. S. Rao, "Applied Numerical Methods for Engineers and Scientists", Prentice Hall 2002
8. And a million other.

Topics:

1. Introduction to errors
2. Rootfinding
3. Interpolation and approximation
4. Numerical integration and differentiation
5. Numerical solution of systems of linear equations
6. Data fitting, least squares
7. The eigenvalue problem
8. Numerical solution of nonlinear systems of equations
9. Numerical solution of ordinary differential equations
10. Introduction to the solution of partial differential equations (time allowing)