Numerical Analysis, Math 4315/5315

http://www.math.lamar.edu/faculty/maesumi/list.html

Coordinates: Fall 2011, MWF 12:20-1:10, Lucas 118 and Lucas 209/TBA. Aug 22 - Dec 7. No classes Sept 5, Nov 22-24. Drop deadlines Sept 26, Oct 31. For details see
`http://www.lamar.edu/course-schedules`

Prerequisites: ODE 3301, Linear Algebra 2318, Calculus 2413-5, a programming course (such as ElEN 1301, COSC 1374, COSC 3306), **ability to program, familiarity with: loops (do/for/while), conditionals (if/elseif), functions, arguments, vectors, arrays, input and output.** This is a capstone course in applied analysis, and as such many ideas have to be at your finger tips for you to succeed.

Text: Any of the numerous texts on "Introductory Numerical Analysis" and "Introduction to Matlab" can be of use for this course. Instructor has placed ten texts on reserve in the library. There are many other texts in the stacks as well. Numerous online resources for all the material in this course are readily available. The course web site, available through address above, has notes and links.

Software: You will write your projects in Matlab, an easy-to-learn programing language mainly intended for mathematical applications. (There are some limited similarities between Matlab and C.) In Lucas 209 computer lab you have access to Matlab as well as several other mathematics software such as Maple and Mathematica. Matlab is also available in Gray Library Media Room on the 7-th floor, as well as in some engineering labs.

Alternate Free Software
Scilab is available from http://www.scilab.org (almost compatible with matlab). This is recommended for home use, especially for Windows OS. It is also available in many labs.
Octave is available from http://www.octave.org (almost compatible with matlab).
Maxima is available from http://maxima.sourceforge.net (similar to early Macsyma or Maple/Mathematica).

Contact Information: Mohsen Maesumi `maesumi@gmail.com`, Lucas 206, Phone: 409-880-8766 Office Hours: TR 1:30- 2:50 MWF 1:30-2:30.
If you are coming to office it may be better if you bring exams, notebooks and supporting material. If you want to call in emergency and leave a message make it brief and speak clearly. Send the same message by e-mail later. If you are sending e-mail use a heading that makes your e-mail stand out, e.g. write NUMERICAL ANALYSIS, keep a copy and send it again if you do not get a reply within one business day.

General Objectives In basic math courses you learn a variety of fundamental ideas such as finding roots, derivatives, integrals, and solving differential equations or linear systems. In this course we learn how to approach problems that either do not have a "simple" solution and/or are not easy to solve "by hand". We learn about approximation, origins of error, experimental ways of determining how well an algorithm achieves its objectives and basics of modelling. Students write programs for each objectives listed below.

Objectives for Graduate Students Those who already had a numerical analysis course will study the theoretical basis of algorithms and/or perform a detailed project in consultation with the instructor. In particular students may write programs related to applied partial differential equations such as solving heat or Laplace equations or develop a segment of a major table of numerical values such as those used in statistics.

Tests and Projects: There will be three equally weighted projects and three open notebook in-the-lab tests. Students are allowed to have their own programs in a portable format (such as a usb stick). You are to test your lab computer and printer before the start of each exam. Use of any type of live communication is forbidden during tests. If you are going to be absent from an in-class test let me know as soon as possible and be prepared to show written proof of emergency.

Syllabus and Detailed Objectives

(0) Introduction to MATLAB

(1) Solution of nonlinear equations

(1.a) Newton method

(1.b) Secant method

(1.c) False position method

(1.d) Bisection method

(1.e) Fixed-point iteration method

(2) Error analysis

(2.a) Taylor Series Theorem

(2.b) The rate of convergence of Newton method

(3) Quadrature rules for computation of definite integrals

(3.a) Midpoint rule

(3.b) Trapezoid rule

(3.c) Simpson rule

(3.d) Newton-Cotes rules

(3.e) Gaussian rules

(3.f) Richardson extrapolation and Romberg algorithm

(4) Error analysis

(4.a) The order of each method

(5) Initial value problems, ordinary differential equations, single-step RKF methods

(5.a) Euler's method

(5.b) Midpoint method

(5.c) Third order methods

(5.d) Fourth order methods

(5.e) Runge-Kutta family of methods

(6) Error Analysis

(6.a) The order of each method

(7) Systems of differential equations and predator-prey models

(7.a) Role of eigenvalues and eigenvectors

(8) Boundary value problems and shooting method

Additional Graduate Level (5315) Syllabus:

(9) Numerical solution of parabolic partial differential equations

(9.a) Finite difference methods

(9.b) Explicit methods

(9.c) Implicit methods (Crank-Nicolson)

(9.d) Von-Neuman Stability analysis