

Spring 2016

Syllabus for Math 407 – Numerical Analysis (3)

Course Description: Numerical solution of equations, numerical integration and differentiation, and numerical solution of ordinary and partial differential equations.

Prerequisite: Math 307 or 311 and one semester of programming, or consent.

Extended Course Description: Introduction to algorithms for solving mathematics problems. The course will focus on numerical solutions of linear/nonlinear systems of equations, numerical integration and numerical differentiation, initial value problems for ordinary (and systems of ordinary) differential equations and boundary value problems. The focus of this class is on practical computation, and the course will serve as a basic introduction to programming for numerical analysis using the software Matlab.

Approximate timeline:

Week 1: Notions of Programming. Introduction to Matlab.

Week 2: Linear systems of equations. Gauss-Jordan method. LDU decomposition.

Week 3: Linear Algebra. Matlab functions for linear Algebra. Matrix Exponential.

Week 4-5: Nonlinear equations. Bisection method, fixed-point iteration method, Newton's method, secant method, multivariate Newton's method for nonlinear systems of equation.

Week 6: Numerical Integration and Differentiation. Finite differences, error estimate, trapezoid rule, Simpson's rule.

Week 7-13: ODE's. Theory, existence and uniqueness. Stability. Euler's method. 1-step error vs. global error. Trapezoid method, diagonalizable systems of ODEs, applications, Runge-Kutta, variable step-size methods, stiff equations and implicit methods, multi-step methods.

Week 14-16: Boundary value problems. Shooting, finite difference, linear splines, collocation, Gallerkin's method, finite elements method.

Textbooks:

Numerical Analysis, second edition by Timothy Sauer, Pearson and

Numerical Methods using Matlab, Third Edition by G.G. Lindfield and J. E. T. Penny, Academic Press

Course Objectives:. Upon successful completion, the student will have a foundation in the basic topics of the theory of Numerical Analysis listed above in the syllabus. Emphasis on rigor will provide students the understanding needed for graduate work, and in the study of the logical foundations of mathematics.

Program Objectives:. Math 407 is a senior level course in Numerical Analysis, an important subject with many applications in the physical and biological sciences, and Engineering. This course promotes our goal that our students learn, understand, and be able to apply several mathematical topics at the junior and senior level, and that our students acquire the ability and skills to apply mathematics to other fields.