Math 4365-13670 (Spring 2012): Numerical Analysis *

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Texts

Numerical Analysis, by R. L. Burden and J. D. Faires, Thomson Brooks/Cole, 8th edition 2005 (ISBN 978-053-439-200-0) or 9th edition 2011 (ISBN: 978-053-873-351-9)

Objectives

To introduce modern numerical techniques; to explain how, why, and when they can be expected to work; and to provide a foundation for further study of numerical analysis and scientific computing.

Remarks

This is the second semester of a two-semester course. The focus in this semester will be on interpolation and polynomial approximation, numerical differentiation and integration, numerical solutions to ordinary differential equations, and numerical solutions to partial differential equations.

Prerequisites

MATH 2331 (formerly 2431), MATH 3331.

*This syllabus contains important information about this course to which you will need to refer from time to time.

Course Policies and Procedures

Grades: Homework (40 percent), Tests (20 percent), Exams (40 percent)

Exams: All Exams will be given in class (one hour and half). Students with a valid excuse for missing up to one exam must provide written documentation to that effect, e.g., a medical certificate. No make-up exams will be given.

Tests: All Tests will be given in class (half hour).

Homework: You may, with impunity, submit up to two assignments up to one class period (not one week) beyond their due date. Subsequent submissions will incur penalties in increments of 10%. Homework submitted later than one class period beyond its due date will not be accepted without a written excuse. Computer program source code must be turned in and must adhere to the programming standards. Homework scores can not be changed one week after they have been returned.

Honor Code Policy: You are encouraged to discuss homework with your classmates. However, you are expected to individually write up your solutions.

Course Outline, Homework, Reading, and Exam Dates[1]

- **3 Interpolation and Polynomial Approximation**
  - Lecture 1 (Jan. 17) 3.1 Interpolation and the Lagrange Polynomial
  - Lecture 2 (Jan. 19) 3.2 Data Approximation and Nevilles Method, 3.3 Divided Differences
- Assignment 1 (Jan. 24)
  - 8th-edition: 3.1 (1.a,3.a,11.a,13,15,17,21,23,24)
  - 9th-edition: 3.1 (1.a,3.a,11,17);3.2(3.a,4,6,7,9)
  - Lecture 3 (Jan. 24) 3.4 Hermite Interpolation, 3.5 Cubic Spline Interpolation
  - Lecture 4 (Jan. 26) 3.5 Cubic Spline Interpolation (cont.)
- Assignment 2 (Jan. 31)
  - 8th-edition: 3.2(11,13,15);3.3(1.a,3.a,9);3.4(1,12)
  - 9th-edition: 3.3(11,13,15);3.4(1.a,3.a,9);3.5(1,12)
- Review and Test 1 (Jan. 31)
- **4 Numerical Differentiation and Integration**
  - Lecture 5 (Feb. 2) 4.1 Numerical Differentiation, 4.2 Richardsons Extrapolation
  - Lecture 6 (Feb. 7) 4.3 Elements of Numerical Integration, 4.4 Composite Numerical Integration
- Assignment 3 (Feb. 9)
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  - Lecture 7 (Feb. 9) 4.5 Romberg Integration, 4.6 Adaptive Quadrature Methods, 4.7 Gaussian Quadrature
  - Lecture 8 (Feb. 14) 4.8 Multiple Integrals, 4.9 Improper Integrals
- Assignment 4 (Feb. 16)
- Review and Test 2 (Feb. 16)

[1]This schedule, including dates of exams, is subject to change. Changes will be announced in class.

- **5 Initial-Value Problems for Ordinary Differential Equations**
  - Lecture 9 (Feb. 21) 5.1 The Elementary Theory of Initial-Value Problems, 5.2 Eulers Method, 5.3 Higher-Order Taylor Methods
  - Lecture 10 (Feb. 23) 5.4 Runge-Kutta Methods, 5.5 Error Control and the Runge-Kutta-Fehlberg Method
- Assignment 5 (Feb. 28)
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  - Lecture 11 (Feb. 28) 5.6 Multistep Methods, 5.7 Variable Step-Size Multistep Methods, 5.9 Higher-Order Equations and Systems of Differential Equations
  - Lecture 12 (Mar. 1) 5.9 Higher-Order Equations and Systems of Differential Equations, 5.10 Stability, 5.11 Stiff Differential Equations
- Assignment 6 (Mar. 6)
- Review and Test 3 (Mar. 6)
- **EXAM I (Mar. 8)**
- **8 ApproximationTheory**
  - Lecture 13 (Mar. 20) 8.1 Discrete Least Squares Approximation, 8.2 Orthogonal Polynomials and Least Squares Approximation
  - Lecture 14 (Mar. 22) 8.3 Chebyshev Polynomials and Economization of Power Series, 8.4 Rational Function Approximation, 8.5 Trigonometric Polynomial Approximation
  - Lecture 15 (Mar. 27) 8.6 Fast Fourier Transforms
- Assignment 7 (Mar. 29)
- Review and Test 4 (Mar. 29)
- **11 Boundary-Value Problems for Ordinary Differential Equations**
  - Lecture 16 (Apr. 3) 11.1 The Linear Shooting Method, 11.2 The Shooting Method for Nonlinear Problems
  - Lecture 17 (Apr. 5) 11.3 Finite-Difference Methods for Linear Problems, 11.4 Finite-Difference Methods for Nonlinear Problems
  - Lecture 18 (Apr. 10) 11.5 The Rayleigh-Ritz Method
- Assignment 8 (Apr. 12)

- **12 Numerical Solutions to Partial Differential Equations**
  - Lecture 19 (Apr. 12) 12.1 Elliptic Partial Differential Equations
  - Lecture 20 (Apr. 17) 12.2 Parabolic Partial Differential Equations
  - Lecture 21 (Apr. 19) 12.3 Hyperbolic Partial Differential Equations
- Assignment 9 (Apr. 24)
- Review and Test 5 (Apr. 24)
- **EXAM II (Apr. 26)**