

M 348. Scientific Computation in Numerical Analysis.

Unique #54215, QR Flag, Fall 2018

Solving scientific, engineering, and other problems often requires the use of numerical methods and computers. This course presents various basic numerical methods, discusses their mathematical properties, and provides practice in computer programming.

Instructor:

Prof. Todd Arbogast Office: RLM 11.162, Phone: 512-471-0166
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Teaching Assistant:

Mr. Lingfan Chen Office: RLM 11.130
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Prerequisite: CS 303E or 307 (or any introductory programming course) and M 341 or 340L with a grade of at least C-.

Meeting: MWF 9:00–10:00 a.m. in RLM 5.104. Attendance is required at all class meetings.

Textbooks:

- [1] Timothy Sauer, *Numerical Analysis*, 3rd Ed., 2017, Pearson. ISBN13: 9780134696454 or ISBN10: 013469645X (Required).
- [2] Mike McGrath, *C++ Programming in Easy Steps*, 5th ed., 2017, In Easy Steps Limited; ISBN-13: 978-1840787573 or ISBN-10: 1840787570 (or the 4th edition) (Optional).

Web Pages: We use the University's Canvas (<http://canvas.utexas.edu>) web site. Please check that your scores are recorded correctly in Canvas. You can access Canvas from my.utexas.edu.

Course Description: We will study primarily Chapters 0–3, 5–6 of the Sauer textbook.

0. Fundamentals (3 classes)
 - 0.1. Evaluating a Polynomial
 - 0.2. Binary Numbers
 - 0.3. Floating Point Representation of Real Numbers
 - 0.4. Loss of Significance
1. Solving Equations (7 classes)
 - 1.1. The Bisection Method
 - 1.2. Fixed-Point Iteration
 - 1.3. Limits of Accuracy
 - 1.4. Newton's Method
 - 1.5. Root-Finding without Derivatives
 - Reality Check 1: Kinematics of the Stewart platform
2. Systems of Equations (7 classes)
 - 2.1. Gaussian Elimination
 - 2.2. The LU Factorization
 - 2.3. Sources of Error
 - 2.4. The PA = LU Factorization
 - Reality Check 2: The Euler-Bernoulli Beam
3. Interpolation (7 classes)
 - 3.1. Data and Interpolating Functions
 - 3.2. Interpolation Error
 - 3.3. Chebyshev Interpolation
 - 3.4. Cubic Splines
 - 3.5. Bézier Curves [if time permits]

- Reality Check 3: Fonts from Bézier curves
- 5. Numerical Differentiation and Integration (7 classes)
 - 5.1. Numerical Differentiation
 - 5.2. Newton-Cotes Formulas for Numerical Integration
 - 5.3. Romberg Integration [if time permits]
 - 5.4. Adaptive Quadrature [if time permits]
 - 5.5. Gaussian Quadrature
 - Reality Check 5: Motion Control in Computer-Aided Modeling
- 6. Ordinary Differential Equations (9 classes)
 - 6.1. Initial Value Problems
 - 6.2. Analysis of IVP Solvers
 - 6.3. Systems of Ordinary Differential Equations
 - 6.4. Runge-Kutta Methods and Applications
 - Reality Check 6: The Tacoma Narrows Bridge
 - 6.5. Variable Step-Size Methods
 - 6.6. Implicit Methods and Stiff Equations
 - 6.7. Multistep Methods [if time permits]

Computer Accounts: An account on the Mathematics network can be obtained in the Undergraduate Computer Lab, RLM 7.122. A free web-based C++ compiler can be found at <http://cpp.sh/>.

Homework and Projects: Homework and computer projects will be assigned weekly. It is acceptable for groups of students to help each other with the homework exercises and projects; however, each student must write up his or her own work.

Exams: Two exams will be given during the semester on Fridays, October 5 and November 9. A comprehensive final exam will be given Wednesday, December 19, 7:00–10:00 p.m.

Final Grade: In determining the final grade on the letter plus/minus scale, the homework/projects will count 25%, the two midterm exams will count 20% each, and the final exam will count 35%.

Student Honor Code: “As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity.”

Code of Conduct: The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

Students with Disabilities: Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, <http://diversity.utexas.edu/disability/>. Notify your instructor early in the semester if accommodation is required.

Religious Holidays: Academic accommodation is made for major religious holidays upon request.

Emergency Classroom Evacuation: Occupants of University of Texas buildings are required to evacuate when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside. Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building. Do not re-enter a building unless given instructions by the Austin Fire Department, the University Police Department, or the Fire Prevention Services office.

Counseling and Mental Health Services: Available at the Counseling and Mental Health Center, Student Services Building (SSB), 5th floor, M-F 8:00 a.m. to 5:00 p.m., phone 512-471-3515, web site www.cmhc.utexas.edu.