# Introduction to Numerical Analysis

MAD 4401

Fall 2022

## Instructor


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Office: 460 Little Hall


Office Hours:
- TBD

## Lecture

Mondays/Wednesdays/Fridays

Period 5 (11:45am–12:35pm)

127 Fine Arts C

## Web Site

Canvas:
https://elearning.ufl.edu/

UF UNIVERSITY of FLORIDA

## Course Description

This course is an introduction to the basic techniques of numerical analysis, the study of methods for solving mathematical problems with computers. We will focus on the mathematical theory behind the methods and algorithms used.

**Topics to be covered:**

- binary and floating point representation of numbers (Ch. 0)
- methods to solve algebraic equations (Ch. 1)
- methods to solve systems of equations (Ch. 2)
- interpolation (Ch. 3)
- numerical differentiation and integration (Ch. 5)
- solving ordinary differential equations (Ch. 6)

**Prerequisites:** Linear algebra (MAS 3114 or MAS 4105) with a minimum grade of C and experience with a scientific programming language.

## Textbook

*Numerical Analysis* (3rd edition) by Timothy Sauer

https://www.pearson.com/en-us/subject-catalog/p/numerical-analysis/P200000006340/9780137982189


**ISBN-13:** (Hardcover) 9780134696454; (Loose-Leaf) 9780134697338; (eText) 9780137982189


**Textbook companion web site** (contains MATLAB code, solutions to selected exercises, and additional examples): https://bit.ly/2yN3AEX

## Software

**MATLAB:** Homework assignments will have some MATLAB programming using MATLAB Grader (https://grader.mathworks.com).

The full MATLAB software will be used for the course project, which is available on any computing device through UFApps (https://info.apps.ufl.edu) and in computer labs (https://labs.at.ufl.edu/locations/). An alternative option is GNU Octave (https://octave.org).

There will be no MATLAB questions on exams.

## Communication

**Course Announcements:** Posted on Canvas. It is the student's responsibility to make sure they receive notifications for this course.

**Discussion Board:** Homework/content questions should be posted on our class discussion board on TBD.

**Personal Matters:** Students may e-mail the instructor via Canvas Inbox or e-mail using their official UF e-mail address.

## Attendance

Attending lectures are vital to the learning process. Furthermore, a huge part of the transition into your professional careers is being where you are supposed to be when you are supposed to be there. As such, your attendance is expected at every lecture. Furthermore, our focus is on the tasks at hand and not on extraneous activities such as chatting, texting, surfing the web/social media, etc.

The use of personal electronics such as laptops, tablets, and cell phones is distracting to the other students and the instructor. Their use can degrade the learning environment. Therefore, students are not permitted to use these devices during the class period (unless they are being used solely for note taking purposes).

## Grading Scheme

- **15%** **Written Homework**
- **10%** **MATLAB Homework**
- **15%** **Project**
- **30%** **Midterm Exams (15% each)**
- **30%** **Final Exam**

Your final course grade will be no lower than the following:

| | | |
|---|---|---|
| A-=[90,93) | A=[93,100] | |
| B-=[80,83) | B=[83,87) | B+=[87,90) |
| | C=[70,76) | C+=[76,80) |
| | D=[60,70) | |
| | E=[0,60) | |

*Grades are based only on academic work and are calculated using the same criteria for all students. It is unethical to bring to your instructor's attention the possible impact of your mathematics grade on your future plans, including graduation, scholarships, jobs, etc.*

More information on UF grading policies (including requests for withdrawal (W) or incomplete (I*/I) grades) may be found at:

https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/

## Written Homework

Written homework assignments showing all work with proper notation will be due weekly via electronic submission through Canvas.

The two lowest Written Homework scores will be dropped at the end of the semester.

## MATLAB Homework

MATLAB homework assignments will be due weekly via MATLAB Grader.

The two lowest MATLAB Homework scores will be dropped at the end of the semester.

## Project

During the second half of the semester, you will have the opportunity to work as part of a team on a project using MATLAB (or GNU Octave). Your team will give an oral presentation (during the last week of class) and write a 5–10 page paper (due on the last day of class).

## Exams

**Midterm Exams** (during lecture)

Wednesday, October 12

Wednesday, November 9

**Final Exam** (comprehensive)

Tuesday, December 13 from 3:00pm–5:00pm

There are no exam retakes or corrections, no lowest exam will be dropped, and there will be no extra credit assignments to erase the consequences of a bad exam score.

## Make-Up Policy for Homework/Exams

Make-up homework/exam work is allowed only when written evidence of an official University excused absence is provided (http://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/).

The instructor must be notified as soon as possible, preferably before the homework due date or exam with as much advanced notice as possible. A detailed account of the situation and supporting documents are required.

*If you do not have an official University excused absence, but are unable to complete homework on time for any reason, see the Late Policy below.*

## Late Policy for Homework

*Late submissions will receive a point deduction of 10% per day late.* Note that late days are counted in 24-hour periods. For example, if the cutoff for on-time submission is 11:59pm, submitting between 12:00am–11:59pm the next day is one day late, and so on. Every assignment has a hard deadline, usually 2 days past the original due date, and late submissions (penalty or not) are *not accepted after the hard deadline*.

## Health and Wellness Resources

- U Matter, We Care
  https://umatter.ufl.edu
- Counseling and Wellness Center
  https://counseling.ufl.edu
- Student Health Care Center
  https://shcc.ufl.edu
- University Police Department
  https://police.ufl.edu
- UF Health Shands Emergency Room/Trauma Center
  https://ufhealth.org/emergency-room-trauma-center
- GatorWell Health Promotion Services
  https://gatorwell.ufsa.ufl.edu
- COVID-19 Testing/Vaccines
  https://one.uf.edu

## Academic Resources

- Teaching Center (tutoring, study groups)
  https://teachingcenter.ufl.edu
- Student Success (tutoring, coaching)
  https://studentsuccess.ufl.edu
- Computing Help Desk
  https://helpdesk.ufl.edu
- Career Connections Center
  https://career.ufl.edu
- Library Support
  https://uflib.ufl.edu/find/ask/
- Writing Studio
  https://writing.ufl.edu/writing-studio/

***Important Note:*** *Information contained in the course syllabus, other than the grade and absence policy, may be subject to change with advance notice, as deemed appropriate by the instructor.*

## Diversity, Inclusion, and Equity

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed.

I am committed to diversity and inclusion of all students in this course. I acknowledge, respect, and value the diverse nature, background, and perspective of students and believe that it furthers academic achievements. It is my intent to present materials and activities that are respectful of diversity: race, color, creed, gender, gender identity, sexual orientation, age, religious status, national origin, ethnicity, disability, socioeconomic status, and any other distinguishing qualities.

## Accessibility and Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the Disability Resource Center by visiting https://disability.ufl.edu/students/get-started/.

It is important for students to share their accommodation letter with their instructor and discuss their access needs as early as possible in the semester.

## Honesty Policy Regarding Cheating, Plagiarism, etc.

UF students are bound by *The Honor Pledge* (http://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/) which states,

> *We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment."*

The Student Conduct Code (http://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of the honor code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please or consult with the instructor in this class.

## Online Course Evaluations

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at http://gatorevals.aa.ufl.edu/students/.

Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via http://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at http://gatorevals.aa.ufl.edu/public-results/.

# Tentative Lecture Schedule

| Monday | Wednesday | Friday |
|---|---|---|
| **August 22nd** | **24th**<br>*First day of class* | **26th**<br>0.1 Evaluating a Polynomial |
| **29th**<br>0.2 Binary Numbers | **31st**<br>**HW #1**<br>0.3 Floating Point Representations of Real Numbers | **September 2nd**<br>0.4 Loss of Significance |
| **5th**<br>**No Classes** (Labor Day) | **7th**<br>**HW #2**<br>1.1 The Bisection Method | **9th**<br>1.2 Fixed-Point Iteration |
| **12th**<br>1.2 Fixed-Point Iteration | **14th**<br>**HW #3**<br>1.3 Limits of Accuracy | **16th**<br>1.4 Newton's Method |
| **19th**<br>1.5 Root-Finding without Derivatives | **21st**<br>**HW #4**<br>2.1 Gaussian Elimination | **23rd**<br>2.2 The LU Factorization |
| **26th**<br>2.3 Sources of Error | **28th**<br>**HW #5**<br>2.4 The PA=LU Factorization | **30th**<br>2.5 Iterative Methods |
| **October 3rd**<br>2.5 Iterative Methods | **5th**<br>2.6 Methods for Symmetric Positive-Definite Matrices | **7th**<br>**No Classes** (Homecoming) |
| **10th**<br>**HW #6**<br>2.7 Nonlinear Systems of Equations | **12th**<br>**Exam #1** | **14th**<br>Discuss Project Requirements<br>3.1 Data and Interpolating Functions |
| **17th**<br>3.1 Data and Interpolating Functions | **19th**<br>3.2 Interpolation Error | **21st**<br>3.3 Chebychev Interpolation |
| **24th**<br>3.4 Cubic Splines | **26th**<br>**HW #7**<br>3.5 Bézier Curves | **28th**<br>5.1 Numerical Differentiation |
| **31st**<br>5.2 Newton–Cotes Formulas for Numerical Integration | **November 2nd**<br>**HW #8**<br>5.2 Newton–Cotes Formulas for Numerical Integration | **4th**<br>5.3 Romberg Integration<br>5.4 Adaptive Quadrature |
| **7th**<br>**HW #9**<br>5.5 Gaussian Quadrature | **9th**<br>**Exam #2** | **11th**<br>**No Classes** (Veterans Day) |
| **14th**<br>6.1 Initial Value Problems | **16th**<br>6.2 Analysis of Initial Value Problem Solvers | **18th**<br>6.2 Analysis of Initial Value Problem Solvers |

| Monday | Wednesday | Friday |
|---|---|---|
| **21st**<br>*Last day to withdraw from courses with W*<br>6.3 Systems of Ordinary Differential Equations | **23rd**<br>**No Classes** (Thanksgiving) | **25th**<br>**No Classes** (Thanksgiving) |
| **28th**<br>6.3 Systems of Ordinary Differential Equations | **30th**<br>**HW #10**<br>6.4 Runge–Kutta Methods and Applications<br>6.5 Variable Step-Size Methods | **December 2nd**<br>6.6 Implicit Methods and Stiff Equations<br>6.7 Multistep Methods |
| **5th**<br>Project Presentations | **7th**<br>*Last day of class*<br>*Last day to petition to your college for late withdrawal*<br>**HW #11**<br>Project Presentations | **9th** |

**Tuesday, December 13**

**Final Exam**
3:00pm–5:00pm

## In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.