Math 475A, Mathematical Principles of Numerical Analysis
Fall 2020, Live Online

Description of Course:
This course is an introduction to the basic techniques of numerical analysis and provides insight into both the theory and algorithms for fundamental mathematical problems associated with systems of equations, optimization, and approximation of functions. The course assumes familiarity with linear algebra and calculus, and requires the use of the programming language, MATLAB.

Course Preqrequites and Co-requisites:
MATH 254 or 355 or 250B, and MATH 215 or 310 or 313 or 410, and the ability to program in C, Python, or MATLAB.

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Tutoring: http://math.arizona.edu/~tutoring
Official course communication: duronc@math.arizona.edu

Official course website:
https://d2l.arizona.edu/d2l/home/927430
Course Location: Live Online via Zoom on D2L
Office Hours: Held Online via Zoom, see D2L
Monday 3pm – 4pm
Wednesday 3pm – 4pm
Thursday 11am – 12pm

Makeup Policy for Students Who Register Late:
Students who register after the first course meeting may make up missed assignments/quizzes within two weeks upon successful registration. Additional time will be granted based upon the approval of the instructor.

Course Format and Teaching Methods:
This class is scheduled to be taught in the Live Online modality.

Class Meetings:
The class will meet Tuesdays and Thursdays at 9:30AM – 10:45M via Zoom. The Zoom link for each meeting may be accessed through the Calendar on the D2L course page. Our synchronous meetings will give us the opportunity to develop our understanding of the content material and work to meet the course goals and objectives using a variety of instructional techniques. All lecture materials will be posted to the D2L course page before/after each class meeting.

Class Attendance:
Although regular attendance is not required, you are expected to keep up with any and all missed material.

- If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
- Notify your instructors if you will be missing an in person or online course.
- Campus Health is testing for COVID-19. Please call (520) 621-9202 before you visit in person.
- Visit the UArizona COVID-19 page for regular updates.
- Students who need to miss more than one week of classes in any one semester must provide a doctor's note of explanation to DOS-deanofstudents@email.arizona.edu.

Class Recordings:
For lecture recordings, which are used at the discretion of the instructor, students must access content in D2L only. Students may not modify content or re-use content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies are subject to suspension or civil action.

Course Communications:

It is the student's responsibility to keep informed of any announcements, syllabus adjustments or policy changes made during scheduled classes, by email, or through D2L. Course-wide announcements will be distributed using D2L. Emails may also be sent to the instructor directly using duronc@math.arizona.edu.

Course Goals and Objectives:

Topics to be covered will include:

- Round-off errors and computer arithmetic
- Algorithms and convergence
- The bisection method of solving equations
- Fixed-point iteration for solving equations
- Newton's method and the Secant method for solving equations
- Error analysis for iterative methods
- Zeros of polynomials and Müller's method
- Interpolation and the Lagrange polynomial
- Neville's method
- Divided differences
- Hermite interpolation
- Cubic-spline interpolation
- Numerical differentiation
- Richardson's extrapolation
- Newton-Cotes quadrature and Gaussian quadrature
- Composite numerical integration and Romberg integration
- Adaptive quadrature methods
- Multiple integrals and improper integrals
- Direct methods for solving linear systems
- Iterative techniques in matrix algebra such as the Jacobi and Gauss-Siedel iterative methods, and relaxation techniques

Learning Outcomes:

By the end of the semester, the anticipated learning outcomes include the following:

- Students will have knowledge of important numerical methods, including strategies both for constructing methods and analyzing them, often with the help of linear algebra
- Students will have knowledge of the limitations of various mathematical approximations and the effect of computer rounding errors
- Students will have knowledge of some concrete methods for solving various kinds of equation systems and optimization problems and methods for approximating functions with the help of simpler functions, such as polynomials and piecewise polynomials
- Students will have knowledge of effective programming of numerical methods
- Students will have knowledge of numerical methods to solve practical problems, including interpretation and analysis of the results, and understanding of the importance of reproducibility
- Students will have knowledge of the presentation and communication of the results of computations

Textbook (Not Required):

- Burden, Richard L., and J. Douglas Faires. *Numerical Analysis*. 10th ed. Cengage Learning, 2015. ISBN: 1305253663.

Required Materials:

- **Special tools**: MATLAB (See https://softwarelicense.arizona.edu/mathworks-matlab for instructions on how to download the software)

- **Equipment and software requirements**: For this class you will need daily access to the following hardware: laptop or web-enabled device with webcam and microphone; regular access to reliable internet signal; ability to download and run the following software: web browser, MATLAB, PowerPoint, Adobe Acrobat.

- **Note**: Enrolled students can borrow technology from the UA Library on a first come, first served basis (See https://new.library.arizona.edu/tech/borrow or https://student.it.arizona.edu/resources for details)

Assignments and Examinations:

Homework (250 points): Homework assignments will be regularly posted at the D2L course page and may be accessed through the Assignments tab. There are, tentatively, ten homework assignments scheduled for the semester. The due date for each assignment is posted on the Calendar on the D2L course page. It is your responsibility to know when the assignments are due. Although the assignments should be turned in before the due date, extensions and late work will be granted in certain situations. Please notify the instructor ahead of time if there is a (reasonable) conflict with any of the assignment due dates. A final homework score based on 250 possible points will be computed by taking the earned average percentage of all homework and multiplying it by 250.

Midterm Examinations (200 points): Two midterm (in-class) examinations are tentatively scheduled for Tuesday, October 13th and Tuesday, November 24th. Each exam will be worth 100 points. Exams will take place online during our regularly scheduled class meeting time and will be written to be completed within one hour. It will be delivered as a PDF. It will be accessible through the Assignments tab on the D2L course page, and students will be expected to upload solutions through D2L. All exams are closed book and closed notes. Peer collaboration of any kind is not allowed during the exams. The exams will be proctored using Zoom in Gallery Mode, with video sharing. Any student who has concerns about sharing video during an exam must meet with their instructor at least two weeks prior to the exam to discuss options. This is not a conversation that can take place immediately prior to an exam. If you miss an exam for any reason, contact your instructor as soon as possible. In general, there will be no make-up exams without prior arrangement with the instructor. However, a make-up exam may be given in exceptional circumstances. Approval in these cases is at the sole discretion of the instructor and/or the dean of students, and decisions will be made on a case-by-case basis. This may require providing a detailed account of the situation. According to university policy, no exams will be held on the week of December 7th. A final midterm #1 exam score based on 100 possible points will be computed by taking the earned percentage of the midterm #1 exam and multiplying it by 100. A similar computation will be used to determine a final midterm #2 exam score based on 100 possible points.

Final Project (150 points): For the final project, twelve teams of two (maximum three) will be preassigned by the instructor. Each team will select a topic from a suggested list of topics that have not been covered during class. Each member of each team is required to submit an individually written report by November 24. Each team will present during class on either December 1, December 3, and December 8, where four teams will present per meeting. Additional details for the final project, along with each team of two (or three), are posted to the D2L course page. A final project score based on 150 possible points will be computed by taking the earned average percentage of the written report and presentation and multiplying it by 150.

Grading Scale and Policies:

Your final course grade will be determined by a percentage of the 600 total possible points in the course, with grades not lower than the following:

A: 100-90% B: 89-80% C: 79-70% D: 69-60% E: 59-0%

- No extra credit or bonus points are offered in this course.

- University policy regarding grades and grading systems is available at http://catalog.arizona.edu/policy/grades-and-grading-system

Incomplete (I) or Withdrawal (W): Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Dispute of Grade Policy: Any questions regarding the grading of any assignment, or exam need to be cleared up within one week after the graded item has been returned.

Classroom Behavior Policy:

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. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Students are asked to refrain from disruptive conversations with people during lecture. Students observed engaging in disruptive activity will be asked to cease this behavior. Those who continue to disrupt the class will be asked to leave lecture or discussion and may be reported to the Dean of Students.

Netiquette:

Netiquette is an abbreviation for "internet etiquette" – more simply put, guidelines for communicating online to ensure meaningful and polite exchanges. The common standards listed below work well for both the online classroom and beyond in professional online communication:

- **Behavior**. Maintain the same standard of behavior and ethics that you would follow in a face-to-face context.
- **Tone**. Treat others with respect. Be mindful of your tone and how that is conveyed in your writing style. DO NOT USE ALL CAPS. It is considered shouting and not appropriate in a classroom. Avoid sarcasm and irony as it is easily misinterpreted in an online environment.
- **Clarity and Content**. Be succinct. Write, reread, and then post. Carefully consider what you have written. Does it make sense? Is it free from errors? Does it add to the conversation? Is it unnecessarily confrontational or offensive?
- **Contribute**. Online learning is not passive. It is expected that you will share your knowledge and insight. Be an active contributor to the learning community.
- **Be forgiving**. If someone makes a mistake or does something inappropriate, address it privately and politely. You can always let the instructor know and ask them to address it as well.

Additional Resources for Students:

- **UA Academic policies and procedures** are available at http://catalog.arizona.edu/policies
- **Student Assistance and Advocacy information** is available at http://deanofstudents.arizona.edu/student-assistance/students/student-assistance
- **Academic advising**: If you have questions about your academic progress this semester, or your chosen degree program, please note that advisors at the Advising Resource Center can guide you toward university resources to help you succeed.
- **Life challenges**: If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or DOS-deanofstudents@email.arizona.edu.
- **Physical and mental-health challenges**: If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520-621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

Accessibility and Accommodations:

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations.

Confidentiality of Student Records:

Policies available at http://www.registrar.arizona.edu/personal-information/family-educational-rights-and-privacy-act-1974-ferpa?topic=ferpa

University-wide Policies link:

Links to the following UA policies are provided here, https://academicaffairs.arizona.edu/syllabus-policies:

- **Absence and Class Participation Policies**
- **Threatening Behavior Policy**
- **Accessibility and Accommodations Policy**
- **Code of Academic Integrity**
- **Nondiscrimination and Anti-Harassment Policy**
- **Subject to Change Statement**

Subject to Change Statement

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.

Tentative Weekly Schedule

Mathematical Principles of Numerical Analysis Calendar - Fall 2020

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Aug 23, 2020	***Aug 24, 2020***	***Aug 25, 2020***	***Aug 26, 2020***	***Aug 27, 2020***	***Aug 28, 2020***	Aug 29, 2020
	First Day of Classes	Introduction 1.1 Calculus Review		Introduction to MATLAB		
Aug 30, 2020	***Aug 31, 2020***	***Sep 1, 2020***	***Sep 2, 2020***	***Sep 3, 2020***	***Sep 4, 2020***	Sep 5, 2020
	Last Day to Add Using UAccess	1.2 Computer Arithmetic		1.3 Algorithm and Convergence **Due HW#1**		
Sep 6, 2020	Sep 7, 2020	***Sep 8, 2020***	***Sep 9, 2020***	***Sep 10, 2020***	***Sep 11, 2020***	Sep 12, 2020
1st Drop Date	Labor Day **Last Day to Add Using UAccess**	2.1 Bisection Method		2.2 Fixed-Point Iteration **Due HW#2**		
Sep 13, 2020	***Sep 14, 2020***	***Sep 15, 2020***	***Sep 16, 2020***	***Sep 17, 2020***	***Sep 18, 2020***	Sep 19, 2020
		2.3 Newton and Secant Methods		2.4 Error Analysis 2.5 Accelerating Convergence		
Sep 20, 2020	***Sep 21, 2020***	***Sep 22, 2020***	***Sep 23, 2020***	***Sep 24, 2020***	***Sep 25, 2020***	Sep 26, 2020
GRO Date		2.6 Zeros of Polynomials		3.1 Interpolating Polynomials **Due HW#3**		

Sep 27, 2020	***Sep 28, 2020***	***Sep 29, 2020***	***Sep 30, 2020***	***Oct 1, 2020***	***Oct 2, 2020***	Oct 3, 2020
		3.2 Neville's Method 3.3 Divided Differences		3.4 Hermite Interpolation		
Oct 4, 2020	***Oct 5, 2020***	***Oct 6, 2020***	***Oct 7, 2020***	***Oct 8, 2020***	***Oct 9, 2020***	Oct 10, 2020
		3.5 Cubic Spline Interpolation		4.1 Numerical Diff. 4.2 Richardson Extrapolation **Due HW#4**		
Oct 11, 2020	***Oct 12, 2020***	***Oct 13, 2020***	***Oct 14, 2020***	***Oct 15, 2020***	***Oct 16, 2020***	Oct 17, 2020
		Midterm #1 **Due Project proposal**		4.3 Elements of Numerical Integ. **Due HW#5**		
Oct 18, 2020	***Oct 19, 2020***	***Oct 20, 2020***	***Oct 21, 2020***	***Oct 22, 2020***	***Oct 23, 2020***	Oct 24, 2020
		4.4 Composite Numerical Integ. 4.5 Romberg Integ.		4.6 Adaptive Quad. Methods 4.7 Gaussian Quad.		
Oct 25, 2020	***Oct 26, 2020***	***Oct 27, 2020***	***Oct 28, 2020***	***Oct 29, 2020***	***Oct 30, 2020***	Oct 31, 2020
		4.8 Multiple Integrals		4.9 Improper Integrals **Due HW#6**		
Nov 1, 2020	***Nov 2, 2020***	***Nov 3, 2020***	***Nov 4, 2020***	***Nov 5, 2020***	***Nov 6, 2020***	Nov 7, 2020
2nd Drop Date		6.1 Linear Systems of Equations	6.3 Linear Algebra, Matrix Inversion 6.4 Determinant of Matrix	6.3 Linear Algebra, Matrix Inversion 6.4 Det. of a Matrix		
Nov 8, 2020	***Nov 9, 2020***	***Nov 10, 2020***	Nov 11, 2020	***Nov 12, 2020***	***Nov 13, 2020***	Nov 14, 2020
		6.5 Matrix Factor.	Veteran's Day	7.1 Norms 7.2 Eigenvalues and Eigenvectors **Due HW#7**		
Nov 15, 2020	***Nov 16, 2020***	***Nov 17, 2020***	***Nov 18, 2020***	***Nov 19, 2020***	***Nov 20, 2020***	Nov 21, 2020
		7.3 Jacobi and Gauss-Seidel		7.4 Relaxation Techniques **Due HW#8**		
Nov 22, 2020	***Nov 23, 2020***	***Nov 24, 2020***	***Nov 25, 2020***	Nov 26, 2020	Nov 27, 2020	Nov 28, 2020
Last Day to Petition for Late Withdrawal		***Midterm #2*** **Due Written report**		Thanksgiving Recess		
Nov 29, 2020	***Nov 30, 2020***	***Dec 1, 2020***	***Dec 2, 2020***	***Dec 3, 2020***	***Dec 4, 2020***	Dec 5, 2020
		Project presentations		**Project presentations** **Due HW#9**		
Dec 6, 2020	***Dec 7, 2020***	***Dec 8, 2020***	***Dec 9, 2020***	Dec 10, 2020	***Dec 11, 2020***	Dec 12, 2020
		Project presentations **Due HW#10**	Last Day of Classes	Reading Day		