

Instructor: Dr. Lingxing Yao **Office** CAS 256 **E-mail** lyao@uakron.edu

Section 01: 12:15 -1:30PM, TTh **Meeting** CAS 138

Office Hours (tentative) TTh1:35PM-2:30PM, W10:00AM-10:50AM. If you cannot make the posted office hours, you are encouraged to make appointments with me at other time with email requests.

Learning Outcomes: students are expected to be able to

- Understand some important basic numerical methods, and know how to implement these methods with programming language like MATLAB
- Understand finite difference method and error analysis
- Construct numerical solutions to ODE problems, and understand the stability issues in the numerical methods
- Numerically solve PDE problems, including basic elliptic, parabolic, and hyperbolic PDEs

Topics to be covered

1. Numerical Differentiation (1-2 week(s))
 - (a) $O(h^p)$ notation
 - (b) Taylor series approximation
 - (c) Forward, backward, and central difference
2. Numerical solutions to ODEs (7-8 weeks)
 - (a) Single step method
 - (b) Runge-Kutta method
 - (c) Multiple step method
 - (d) Boundary value problems
 - (e) Stability analysis of numerical methods
3. Numerical solutions to PDEs (6 weeks)
 - (a) Introduction
 - i. 3 standard PDEs: elliptic, parabolic, and hyperbolic
 - ii. Boundary and initial value problems
 - iii. discretization of PDEs
 - (b) Elliptic equations
 - i. discretization of Laplacian operator
 - ii. Boundary conditions
 - iii. 2D Poisson equation
 - (c) Parabolic equations
 - i. Explicit in time method
 - ii. implicit methods: Backward Euler; Crank-Nicolson; BDF (maybe)
 - (d) Hyperbolic equations
 - i. advection equation
 - ii. wave equation

iii. conservation laws (tentative)

Textbook There is no required textbook. We list several good ones as references: 1) Numerical Methods Using MATLAB, 4th edition, Mathews and Fink; 2) Finite Difference Methods for Ordinary and Partial Differential Equations Steady State and Time Dependent Problems, Randall J. LeVeque; 3) Numerical Computing with MATLAB, Cleve Moler (free online <https://www.mathworks.com/moler/chapters.html>)

Course Website All class related materials (including notes and documents for preparing quiz and test) will be posted on the website <http://brightspace.uakron.edu/>. Please update your email address on the website, since email notifications will be sent to the email registered there, and you don't want to miss important announcement.

Manage your time wisely It's extremely important to have a good study plan and stick to it for the entire semester. It is estimated that at least 3 times of lecture time has to be spent on studying for a math subject studying so a student can do well in the course. So please try to design a feasible plan for yourself and stick to it so you have plenty study time each week. PLEASE DO NOT RELY ON EXTENSIVE STUDY ONLY BEFORE TESTS. IT DOES NOT WORK!

Homework: Your success in this class depends on your time spent on working out the homework problems/programming and review course materials. Homework questions are given regularly and will be counted while calculating course grades. We in general will not accept late submission of homework. But during the semester, each student will be able to turn in one homework late without penalty (within 3 dates of the original due date). For other late submissions, the score will be reduced by 10% for each day late. And more than 5 days of late work will not be accepted. The assignments will have theoretical and programming parts. The submissions of assignments are on Brightspace. For the programming part, students need to upload both the code and the output of the programs in PDF file. (original code also need to be submitted in both standalone code and PDF file)

Grading System One in-class test will be given around the 8th week of the semester. The exact form and time will be announced during the semester, based on our pace. The cumulative **exam 2**, which will cover all sections we study, will be given during the final's week. **Extra credits** will be given occasionally for in class activities, and the maximal will be 100 points and it will give a student extra 1% to their course score. At the middle of the semester, a student could also request to finish a project, which is due before semester is over. The project will account for 30 points and its score could replace the exam 2 score (**all students still need to take the exam 2**). The topic will be assigned right after midterm and it will be about the materials from the second half of the semester. Course grade will be determined by the sum of the scores from homework, and test scores, according to the following percentage:

$$\text{Homework (40\%)} + \text{Test(30\%)} + \text{Final exam(30\%)}$$

(If your course score is 90%, it will guarantee an A^- ; the course score of 80% will guarantee at least a B^- ; the course score of 70% will guarantee a C^- , and the course score of 60% will guarantee a D^- . This will be a guidance and usually adjustments are made in determine the grade letter.)

Make-Up are **NOT** given unless excused by the instructor **before** tests are given. The instructor has the right to determine whether to allow or deny the request from a student. If permitted, a make-up exam must be taken within one week of the scheduled exam. The only exceptions are extreme emergencies, such as hospitalization, incarceration or alien abduction.

STUDENTS WITH DISABILITIES: Pursuant to University policy #33-59-20-01 subsection C, The University of Akron recognizes its responsibility for creating an institutional atmosphere in which students with disabilities have the opportunity to be successful. Any student who feels he/she may need an accommodation based on the impact of a disability should contact the Office of Accessibility at 330-972-7928 (v), 330-972-5764 (tdd) or access@uakron.edu. The office is located in Simmons Hall Room 105. Accommodation letters for

students with certified disabilities will be sent to instructors electronically. Students will request and coordinate all of their accommodations through the Student Testing and Accommodation Request System (STARS).

IMPORTANT NOTICE: The University of Akron is committed to providing an environment free of all forms of discrimination, including sexual violence and sexual harassment. This includes instances of attempted and/or completed sexual assault, domestic and dating violence, gender-based stalking, and sexual harassment. If you (or someone you know) have experienced or experiences sexual violence or sexual harassment, know that you do not need to handle this alone. Help is available, regardless of when the violence or harassment occurred, and even if the person who did this is not a student, faculty or staff member. Confidential help is available. If you wish to speak to a professional, in confidence, please contact:

- University Counseling and Testing Center – uakron.edu/counseling 330-972-7082
- Rape Crisis Center – www.rccmsc.org – 24 Hour Hotline: 877-906-RAPE
- The office is located in the Student Recreation and Wellness Center 246 and the office number is: 330-972-6328
- University Health Services – uakron.edu/healthservices 330-972-7808

Please note that I, as well as the majority of other University of Akron employees, am considered to be a “responsible employee” under the law and am required to report sexual harassment and sexual violence. If you tell me about a situation, I will be required to report it to the Title IX Coordinator and possibly the police. You will still have options about how your case will be handled, including whether or not you wish to pursue a law enforcement or complaint process. You have a range of options available and we want to ensure you have access to the resources you need. Additional information, resources, support and the University of Akron protocols for responding to sexual violence are available at uakron.edu/Title-IX.

What students need to know? Please see the link: <https://www.uakron.edu/oaa/faculty-affairs/What-students-need-to-know>

- The Student Code of Conduct and academic misconduct
- Statement about the ethical use of ChatGPT and other AI tools
- Inclusive Excellence
- Title IX
- Sexual harassment and sexual violence
- Students with disabilities
- Religious accommodations for students
- ZipAssist

Matlab resources

- <https://www.evamariakiss.de/tutorial/matlab/>
- <https://www.mathworks.com/help/matlab/getting-started-with-matlab.html>
- <https://ocw.mit.edu/courses/2-086-numerical-computation-for-mechanical-engineers-fall-2014/pages/matlab-tutorials/>

Declaration of Generative AI Use (template)

Reminder of Course Policy

- The use of GenAI tools (e.g., ChatGPT, Gemini, Llama, Deepseek) for completing any part of this course is discouraged.
- Using these tools is not needed to be successful in the class and could be detrimental to your learning experience.
- If you use them, you must cite the tool you used and explain how you used it.
- If you do not cite the tool, it is an academic code violation.
- We will be using special tools to detect cases of unattributed GenAI use.

Student Declaration

Have you used generative AI tools to complete this assignment:

YES ☐ NO ☒

If you answered YES above, describe what tools you used and what parts of the assignment you used them for below:

Example: I used ChatGPT to debug my convolution implementation