# Vanderbilt University — Civil and Environmental Engineering

# CE 2989 — Numerical Methods in Civil and Environmental Engineering

## Spring 2026

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| **Instructor:** | Ahmad F. Taha | **Time:** | T,TH 11:00 – 12:15 |
| **Email:** | ahmad.taha@vanderbilt.edu | **Place:** | Featheringill Hall 298 |

**Course Pages:**

- Vanderbilt Brightplace: `https://brightspace.vanderbilt.edu`

**Office Hours:**

- Tuesdays and Thursdays, 12:30PM–02:00PM
- Or by appointment
- Location: 293 Jacobs Hall

**TA Info:**

- Gavin Blair
- Office hours: MWFs: 11AM–1PM
- Location: TBA + Zoom Link `https://vanderbilt.zoom.us/j/4465422480`

**Course Description:** Introduction to concepts, algorithms, and methods of numerical analysis, including: *(i)* linear algebra and matrix computations concepts; *(ii)* solving linear and nonlinear systems of equations; *(iii)* matrix decompositions; *(iv)* Newton's method and its variants; *(v)* stability and convergence of numerical methods; *(vi)* numerical interpolation and integration; (vii) finite-difference methods for solving differential equations; *(viii)* optimization problems and linear programming. Applications to basic problems in civil and environmental engineering.

**Main References:** I will be producing lecture notes, guided by these two textbooks

1. Chapra, Steven C. and Canale, Raymond P., *Numerical Methods for Engineers, 8th edition.* Mcgraw-hill, 2021.
2. Chapra, Steven C., *Applied numerical methods with MATLAB for engineers and scientists*. Mcgraw-hill, 2018.

and some online references that I will be reproducing and providing to the students. The two textbooks are very similar and are available as e-books online. If I were you, I would stick to my lecture notes (slides) and handwritten notes.

**Prerequisites:**

CS 1100 or 1101 or 1103. Corequisite: MATH 2420.

**Course Learning Objectives:**

- Introduce students to classical numerical methods available for problem solving with applications in civil and environmental engineering.
- Introduce students to concepts such as precision, errors, and tolerances in algorithms as well as convergence analysis and its impact on solving numerical computational problems.
- Enhance students knowledge of linear algebra, calculus, and differential equations.
- Improve the understanding of algorithms and processes.
- Improve basic programming skills and the coding of functions that solve numerical problems.
- Introduce students to mainstream algorithms that perform solving systems of linear equations and numerical integration.
- Introduce students to the concept of mathematical optimization of convex problems.
- Cover applications of optimization and computing in civil and environmental engineering.

**Grading Policy:**

- Homework assignments (0%)
- Midterm 1 (25%): Wednesday February 11, 2026, at 6pm.
- Midterm 2 (25%): Wednesday March 25, 2026, at 6pm.
- Final Exam (40%): Thursday April 23, 2026, at 2pm.
- Attendance and instructor evaluation (10%)

*Course Grade Cutoffs:*

- A-, A, A+: 85–100
- B-, B, B+: 70–84
- C-, C, C+: 55–69
- D-, D, D+: 40–54
- F: $\leq 39$

**Recitation Sessions:**

The course TA, Gavin Blair, will have a Zoom session few days before the homework due date to go over the homework and help you out. We will announce these sessions and provide the zoom link.

**On Homework Assignments:**

Large language models (LLM) and their many manifestations have gotten so good. They can solve most of the homework assignment problems I assign you—but they cannot be trusted in designing future bridges, water systems, or energy networks which is why you need this class. The solution to this issue (of LLMs being so good and many students not doing the homework themselves) is simple. I will post the homework assignments with a due date, and you can choose to submit the homework solutions on time or not; the grade allocation is 0%. So it is up to you. This will be your exercise in discipline and

motivation. The homework solutions will be posted and if we are have time, I will occasionally go through the solutions and give hints in class or during office hours.

**On Exams:**

The exams will be closed book, closed notes, closed technologies, closed pretty much everything besides one A4 paper of your own notes. You will not be required to memorize anything for the exam and the exam will only be testing your understanding of the material. The exams, the three of them, will be very similar to the homework assignments. An objective of mine from this class is to also assess and train your discipline, and to also observe who worked on the homework and who has *not*.

**Programming Tools:**

MATLAB will be required for homework assignments. You can definitely use Python if you prefer that. Students can obtain the discounted student version of MATLAB online or through the university bookstore. Also, students are encouraged to use LaTeX for their homework assignments. I'm happy to provide latex templates that I use for the slides and homework assignments. Email me and I'll send them to you.

**Class Policy:**

- **Regular attendance** is essential and expected. The course instructor will occasionally take attendance and this will be counted towards the overall course grade. Students are allowed to miss at most two classes when the attendance is recorded.
- Students are expected to show few minutes **before** the start of the class. It is the student's responsibility to plan ahead of time and inform the course instructor of any emergencies. In case the student anticipates that they will be late for class, he/she should email the instructor before the class starts. Late arrival to class will negatively influence the attendance and instructor's evaluation grade.
- **Late submission policy:** [this policy is obsolete now as homework assignments will *not* be graded, I kept it for your eyes only] besides medical and family emergencies (a written verification is required), there will be no extensions granted for submissions. Late submissions will be scaled according to lateness, removing 10% from your assignment grade per day late, up to a maximum of 50%. Submissions more than 5 days late will be assigned a score of 0.
- **Changes to the syllabus:** students will be regularly informed about any changes for the course syllabus. I anticipate absolutely no changes to the grading scheme in the syllabus, but perhaps some changes to the tentative course outline will occur.

**Tentative Course Outline:**

Module I — Class Overview & Background ..... ≈ 1 class
Course introduction & syllabus, topics to be covered, and applications
Module II — Mathematical Modeling, Matlab, and Error Analysis ..... ≈ 3–4 classes
Revision of basic mathematical concepts and introduction of error analysis
Module III — Finding Roots ..... ≈ 4–5 classes
Computing roots of equations $f(x) = 0$ via bisection, Newton, and other methods
Module IV — Solving linear system of equations ..... ≈ 3–4 classes
Methods to solve $Ax = b$ and matrix factorization
Module V — Curve Fitting, Interpolation, and Fourier Analysis ..... ≈ 3–4 classes
Where we learn some fundamental methods used in the Anthropocene's digital age
Module VI — Numerical Integration and Differentiation ..... ≈ 4–5 classes
Because like who wants to integrate manually?!
Module VII — Numerical Methods to Solve ODEs ..... ≈ 3–4 classes
You see how computers solve ODEs (spoiler alert: Matlab didn't take the ODE class)
Module VIII — Numerical Methods to Solve PDEs ..... ≈ 3–4 classes
Not sure we will have time for this but let's at least try

**Academic honesty:**
Cheating, plagiarism, or any act of dishonesty will NOT be tolerated. This includes, but is not limited to, copying from another students paper or assignment and copying from published material. Students are responsible for the content of the Honor Code. Any violation will be reported to the Honor Council. Students are bound by all provisions of the Honor Code, found in the Vanderbilt Student Handbook (http://www.vanderbilt.edu/student_handbook/the-honor-system/).

Other pertinent material may be found at the Honor Councils website, https://studentorg.vanderbilt.edu/honorcouncil/. Report any violation of the Honor Code at https://cm.maxient.com/reportingform.php?VanderbiltUniv&layout_id=2

Specific considerations for this course include:

- Use of Chegg, Slader, Course Hero or similar sites is not allowed in this course.
- Collaborative work with classmates is encouraged, however all work you submit must be your own. Copying someone elses work, with or without their permission, is an Honor Code violation in this class.
- If you have questions or concerns about Honor Code issues in this class, please talk with me

**Excellence and Inclusion**
It is my belief that everyone in this class can excel and that our collective learning experience is improved by including everyone fully. Toward that end, I commit to doing my best to use inclusive language and practices. If you observe actions in which I am not respectful or inclusive, please bring those to my attention.

**Accommodation Policy**
Vanderbilt is committed to equal opportunity for students with disabilities, as am I. If you need course accommodations due to a disability, please contact VU Student Access Services (https://www.vanderbilt.edu/student-access/) to initiate that process. After SAS has notified me of relevant accommodation(s) and you and I have discussed how this(these) may best be approached in this class, I will facilitate the accommodation(s).

**Mental Health & Wellness**
If you are experiencing undue stress that may be interfering with your ability to perform academically, Vanderbilts Student Care Network offers you a range of support services. The Office of Student Care Coordination (OSCC) is the central and first point of contact to help you navigate and connect to appropriate resources. You can schedule an appointment with the OSCC at
https://www.vanderbilt.edu/carecoordination/ or call 615-343-WELL
If you or someone you know needs to speak with a professional counselor immediately, the University Counseling Center offers Urgent Care Counseling. Students should call the UCC at (615) 322-2571 during office hours to speak with an urgent care clinician. You can also reach an on-call counselor after hours or on the weekends by calling (615) 322-2571 and pressing option 2 at any time. You can find additional information at https://www.vanderbilt.edu//ucc/.

**Sexual Misconduct or Power-Based Personal Violence**
If you have experienced sexual misconduct or power-based personal violence, please contact Project Safe (https://www.vanderbilt.edu/projectsafe/), VU Police Department, or the nearest emergency room as best fits your needs. If you share with me any information about such experiences, I am required by law to report this to Vanderbilts Title IX Coordinator.

**Emergency Evacuation Plan**
In the event of a fire or other emergency requiring evacuation, the occupants of this class should leave the building through the exits closest to the classroom. If you need special assistance during an evacuation, please discuss this with me as soon as possible. Vanderbilt University policy forbids reentry to a building in which an alarm has occurred without authorization by Vanderbilt Security.

**Important information COVID-19**
Health and Safety: Our mutual commitment to health and safety is vital. Toward that end, in this class we will all: Wear masks that fully cover nose and mouth at all times; Maintain 6' or greater separation from each other; Stay away from the classroom when not feeling well, when instructed to isolate or quarantine, and when not scheduled to be present in person.
Attendance: If you have any reason to believe that you may be ill or have been a close contact of someone who is COVID-19 positive, do NOT come to class in person. Contact Student Health right away. Participate remotely until you are cleared to return to classes.
No portion of your grade will be tied to in-person attendance.
Online Engagement/Technology Requirements

- All students in this class must have a portable computer that meets the specifications at https://engineering.vanderbilt.edu/transit/ComputerRecommendation.php or those that were in effect during year of entry to VU.
- You must have internet access with a minimum bandwidth of 3 Mbps.
- You must have earphones/headphones with a microphone. These need not be fancy. I do recommend ones that fully occlude the ear canal to cut down on extraneous noise.
- Your full engagement in class sessions is essential not only for your own learning but for the shared educational experience of the class. Toward that end, no use of social media, email, etc. during class is permitted. When participating remotely, you must have your video camera on unless I have granted specific permission otherwise.