Introduction to Numerical Methods of Engineering Analysis

EGM 3344 Sections 4706 and 3415
Class Periods: MWF 7 and 8 (1:55pm-2:45pm and 3:00pm-3:50pm, respectfully)
Location: WEIL 270 and MCCA G186, respectably
Academic Term: Spring 2026

Instructor:
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Office Hours: Wednesdays, 11am-1:30pm, NEB 139

Teaching Assistant/Peer Mentor/Supervised Teaching Students:

- TBA

Course Description

Methods for numerical solution of mathematical problems, with emphasis on engineering applications and computer implementation in MATLAB. Modeling, computers, and error analysis. Roots and optimization. Linear algebraic equations and matrices. Curve fitting. Numerical differentiation and integration. Ordinary differential equations. Credits: 3

Course Pre-Requisites / Co-Requisites

Pre-requisites:	MAC 2313	Analytic Geometry and Calculus 3
	COP 2271 or equivalent	Computer Programming for Engineers MATLAB
Co-requisites:	MAP 2302	Elementary Differential Equations

Course Objectives

The goal of EGM 3344 is to teach you how to apply computational methodologies to solve engineering problems when no closed-form, analytical solution exists. Achievement of this goal requires learning the basics of structured programming as well as learning how to combine engineering knowledge, judgment, and intuition to develop reasonable approximations through the engineering modeling process. Because mathematical judgment and approximations are involved, the material in this course will be somewhat more open-ended than the material covered in other courses. Emphasis will be placed on understanding the concepts behind the various numerical methods studied, implementing basic numerical methods using the MATLAB structured programming environment, and utilizing more sophisticated numerical methods provided as built-in MATLAB functions. This approach is taken since understanding how numerical methods work is essential for choosing the correct method and understanding its limitations. At the same time, the existence of commercial numerical libraries makes it inefficient and unnecessary for students to re-develop complex existing numerical routines.

By the end of this course, you should be able to:

1. *Numerical methods:* Understand the most common numerical methods used in engineering analysis, when to use each method, and how to implement basic methods in a structured manner using MATLAB's programming language.
2. *Numerical accuracy:* Estimate the amount of error inherent in different numerical methods.
3. *Numerical efficiency:* Assess the efficiency of a selected numerical method when more than one option is available to solve a certain class of problem.
4. *Numerical stability:* Understand the convergence properties and limitations of different numerical methods.

Materials and Supply Fees

None

Relation to Program Outcomes (ABET):

This course prepares graduates to have a knowledge of a range of numerical methods for solving a variety of engineering problems as well as the critical thinking required for problem solving in life and engineering.

Outcome	Coverage*
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	
3. An ability to communicate effectively with a range of audiences	Low
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	High

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- Software: MATLAB Student Version (**any recent version** should be fine)
- You may consider using UFApps (not recommended) to access a number of popular software applications for "free" including MATLAB at: http://info.apps.ufl.edu/
- MATLAB is also available for purchase and download at https://www.mathworks.com/products/matlab/student.html
- I recommend against using UFApps and instead purchasing a MATLAB student license because it eliminates friction caused by using UFApps (downloading data files, saving .m files, poor Internet connection, etc.). Furthermore, I highly recommend purchasing the $100 version that comes with Simulink and various toolboxes. While we may not use these in this course explicitly, it is very possible you will need those toolboxes and/or Simulink in future courses (e.g., EML 4312).

Recommended Materials

- Title: *Applied Numerical Methods with MATLAB for Engineers and Scientists*
- Author: Steven C. Chapra
- Publication date and edition: 2017, 4th Edition (McGraw Hill)
- ISBN number: 978-0-07-339796-2
- ***Any recent version*** will suffice for content. However, occasional homework problems may be assigned from the book, and problem numbers sometimes change from one edition to another.
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- ***Recommended Reading***
- We will largely follow the layout of the Chapra book. It is extremely useful. I suggest you read the relevant chapters, especially if you are having issues with the homework.

Required Computer
Recommended Computer Specifications: https://it.ufl.edu/get-help/student-computer-recommendations/
HWCOE Computer Requirements: https://www.eng.ufl.edu/students/advising/fall-semester-checklist/computer-requirements/

Tentative Course Schedule

Week	Topics	Book Chapters	Estimated Assignments
1	Mathematical modeling; MATLAB basics, Euler's method	1, 2, 3	
2	Floating-point representation; round-off error; Taylor series; truncation error	1, 4	HW1
3	Finite-difference approximations; root-finding: bracketing methods	4, 5	HW2
4	Root-finding: Newton-Raphson, secant methods; optimization	6	HW3
5	Gradient descent method; Newton's method of optimization; linear algebra basics	**Not in book**	
6	Cramer's rule; Gauss elimination; LU factorization	8, 9, 10	HW4
7	Matrix inverse; norms; condition number	11	Exam 1
8	Jacobi method; Gauss-Seidel method; generalized Newton-Raphson method	12	HW5
9	Eigenvalues and eigenvectors; linear regression using linear least squares	13, 14	HW6
10	Polynomial regression; multiple linear regression; general linear least squares; nonlinear least squares	14, 15	
11	Fourier analysis: Fourier series, frequency-domain representation of functions	16	HW7
12	Fourier analysis: Fourier transform, discrete Fourier transform; polynomial interpolation	16, 17	HW8
13	Newton-Cotes formulas; Runge-Kutta methods	19, 20	HW9

Important Dates
Thursday, March 5th Exam 1 (8:20pm-10:10pm)
Finals week Final Exam (TBD)

Attendance Policy, Class Expectations, and Make-Up Policy
Attendance
- Regular class attendance is expected although not explicitly included in the grade evaluation.
- The course will be delivered in a hybrid format. A Zoom conference will be created for each lecture for students to attend remotely if they do not wish to come to the classroom.

Homework
- HW will be posted on Canvas along with its due date.
- HW will be turned in on Canvas.
- Some or all assigned problems will be graded for each assignment. You are required to complete all assigned problems.
- Late HW will be accepted up to 24 hours after the due date with a maximum-grade penalty of 20 points. That is, your grade will be rounded down to an 80. If this sounds severe, turn in your homework on time. If you have an absolute doomsday of a week, this is your safety valve. Hardship cases will be considered on an individual basis and only if the instructor has been contacted before the due date of the assignment.

Students with hardship cases (e.g., due to medical problems) will be referred to the Dean of Students office, which will perform a background investigation to determine if the hardship is legitimate.

- If you do not agree with the grading of a HW problem, you will have one week from the date the HW is returned to submit a written argument of why you think the grade should be higher. However, the final decision will remain the instructor's.

Exams

- Exams will be closed-book and closed notes. The instructor will announce, in class, any allowed formula sheets or resources at least one week before the exam.
- No cell phones or calculators (or anything that can store formulae) are allowed during exams. An abacus is allowed if desired.
- Exam problems may be taken directly from the homework problems or from lecture discussions with some modifications. Thus, in addition to the weight placed on homework in the final grade, it is to your advantage to understand as many of the homework problems as possible. The emphasis of the exams will be to test your understanding, not on formulaic repetition, so expect the exam problems to be challenging and to test your grasp of the methods taught in the class.
- Makeup exams are only allowed for students with extreme, documented circumstances. Students must contact the instructor as soon as possible to provide documentation and request a make-up exam. Excused absences must be consistent with university policies in the undergraduate catalog and require appropriate documentation.
- If you do not agree with the grading of a particular exam problem, you will have one week from the date the exam is returned to submit a written argument of why you think the grade should be higher. However, the final decision will remain the instructor's.

E-learning course web site (Canvas)

- Students are expected to check Canvas on a regular basis for up-to-date course information. This may include changes to homework assignment due dates, exam schedules, etc.

Workload

- Numerical Methods requires a great deal of programming, and completing the assignments is the only way to solidify your understanding of the material. The lectures will introduce the material, but **you should expect to spend a significant amount of time on the homework**; this is where the real learning takes place.

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework	30%
Exam 1	35%
Exam 2	35%

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67

0 - 59.9	E	0.00

Academic Policies & Resources
To support consistent and accessible communication of university-wide student resources, instructors must include this link to academic policies and campus resources: https://go.ufl.edu/syllabuspolicies. Instructor-specific guidelines for courses must accommodate these policies.

Commitment to a Positive Learning Environment
The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University's core values.

If you feel like your performance in class is being impacted, please contact your instructor or any of the following:
• Your academic advisor or Undergraduate Coordinator
• HWCOE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
• Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu