Mechanical Engineering
ME 140A, Numerical Analysis in Engineering
Fall, 2022

Course Organization:

Instructor Alexander Meiburg
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TA *None*

Office Hours: By arrangement. Email me, we can meet in person or zoom!

Course Description
The study of numerical analysis and numerical and analytical solutions of engineering problems described by linear and nonlinear differential equations.

Course Prerequisites
Math 3A-C, Math 5A-C, ME 17

Topic Prerequisites
Multivariable calculus including Taylor series and partial differentiation; Ordinary differential equations; Elementary numerical analysis, including root finding methods, polynomial approximations, Newton's method, and numerical differentiation and integration: Working knowledge of MATLAB.

Text, References & Software
Applied Numerical Methods with MATLAB, ***Steven C. Chapra***, McGraw-Hill
Your ODE book

Course Objectives
The objectives of the course are to develop an understanding of the origin and numerical solution of differential equations in engineering.

Topics Covered
1. Numerical integration
2. Numerical differentiation
3. Ordinary differential equations: classifications of equations
4. First order ODEs: Analytical solution methods
5. Transition to chaos: Difference equations, strange attractors
6. Second order linear ODEs: Analytical solution methods
7. Numerical solution of ODEs: Initial value problems
8. Numerical solution of ODEs: Boundary value problems
9. Eigenvalue problems
10. Topics (Phase plane methods, PDEs, or linearized systems)

Credit units of class/laboratory
3 units: 3 lectures/week

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Course Assignments
There will be problem sets approximately every week. These are to be used as *learning experiences* and are intended to reinforce and extend the lecture and reading material. Collaboration with your classmates is encouraged, (with the usual warning about making sure you are learning while collaborating!). Accordingly, the problem sets will not count heavily toward the final grade. But they *are* required and should be turned in on time. There will be no credit for late homework. **Warning:** Not doing the homework will make it nearly impossible to pass the course.

Tests
There will be two midterms and a final. The exam schedule will be announced later.

Grading

Homework	10%
Midterms (2)	60%
Final	30%

Professional Component (re: ABET)
2 units engineering science, 1 unit engineering design

Course Outcomes
Ability to classify differential equations arising in engineering applications

Ability to use analytical methods of solution when possible

Understand the underlying basis of many commonly used numerical techniques for solution of ordinary differential equations

Be aware of pitfalls in the use of numerical methods

Ability to use higher level programming environments, i.e. MATLAB, to solve ordinary differential equations numerically

Ability to derive basic equations from balance laws