- Course Number and Title: M E 533. Numerical Methods for Fluid Mechanics and Heat Transfer
- Catalog Description: Application of fluid mechanics theory and computational approaches to advanced flow problems, including viscous/inviscid and laminar/turbulent behavior. Complex flow problems addressed through development of a theoretical formulation, followed by application of computational fluid dynamic (CFD) tools, and finally presentation and validation of solution data.
- Credit Hours: 3 Credits (3)
- Prerequisite(s) / Corequisite(s): Prerequisite(s): M E 530 or Consent of Instructor
Corequisite(s): None
- Required: Graduate Core
- Course Availability: Spring Semester
- Instructor (Usual): Dr. Andreas Gross (See https://mae.nmsu.edu/people/faculty.html)
- Textbook: *J. H. Ferziger, Numerical Methods for Engineering Applications, Wiley*
- Course Learning Objectives: After completing this course, a student should be able to:
  1) Understand fundamental aspects of solving differential equations using finite difference methods.
  2) Understand fundamental concepts such as stability, accuracy, consistency, systematic errors (phase/amplitude errors), artificial diffusion, etc.
  3) Implement and test algorithms for the solution of ordinary and partial differential equations.
  4) Develop ability to analyze numerical results and report results in a meaningful way.
- Topics Covered:
  - Ordinary differential equations - initial value problems (Euler explicit method, stability, backward or implicit Euler, error estimation and accuracy improvement, predictor-corrector methods, Runge-Kutta methods, multistep methods)
  - System of equations (stiffness, inherent instability)
  - Boundary value problems (shooting method, direct methods, higher-order direct methods, compact methods, nonuniform grids)
  - Classification of partial differential equations
  - Parabolic equations (explicit method, Crank-Nicholson method, Dufort-Frankel method, Keller box method, second-order backward method, high-order methods, two and three spatial dimensions)
  - Other coordinate systems and transformations
  - Nonlinear problems

- Elliptic equations (discretization, iterative methods and their properties, Jacobi method, Gauss-Seidel method, line relaxation, successive overrelaxation, alternating direction implicit methods)
- Hyperbolic equations (time permitting)