CIV 350 – Numerical Analysis for Civil Engineers

Current Catalog Description: Introduction to the formulation and techniques for numerically solving a wide range of problems in engineering with a focus on civil engineering topics. This course provides students with an introduction to principal concepts and methods of numerical analysis, such as (a) fundamental of digital computing using computers; (b) principles of numerical methods and algorithms, and their accuracy and convergence behavior; (c) introducing linear algebra and numerical methods such as direct and iterative techniques to solve the system of linear equations; (d) roots of non-linear equations and their numerical solutions; (e) numerical interpolation and integration; (f) fine-difference method to solve the ordinary differential equations of interest in engineering applications.

Prerequisite: MEC 102; MEC 260

Corequisite: AMS 361; MAT 303; MAT 305

Textbooks and/or Other Reqd Matl: Required Texts:
Timothy Sauer, Numerical Analysis, 3rd edition (2020); and Pre-prepared class notes/slides/videos by the Lecturer, Civil Engineering Department, Stony Brook University (2019).

This course is: Required

1. Introduction to numerical analysis
2. Single non-linear equations and their solutions
   - Fixed point method
   - Mid-point method
   - Newton's method
3. System of linear equations and their solutions
   - Direct methods
     - Naive Gaussian method
     - LU-Factorization
     - PA=LU Factorization
   - Iterative methods
     - Jacobi method
     - Gauss-Seidel
     - Successive Under-relaxation
     - Thomas, Tridiagonal Matrix (TDMA) (direct) method
4. System of non-linear equations and their solutions
   - Newton's multivariate methods
5. Interpolation
   - Linear interpolation method
   - Lagrange method
   - Newton's divided differences
   - Cubic Splines
6. Least square method
   - Solving inconsistent linear system of equations
   - Developing non-linear models
   - Developing power law models
   - Developing exponential models
   - Developing periodic models
7. Numerical integration and differentiation
   - Trapezoid rule
   - Simpson's rule

- Midpoint’s rule

8. Initial value problems and their solutions
    - Explicit Euler scheme
    - Implicit Euler scheme
    - 2nd order Runge Kutta
    - 4th order Runge Kutta
9. Boundary value problems and their solutions

Course Learning Outcomes/ Expected Performance Criteria:

Course Learning Outcomes	ABET Student Outcomes
Understand digital computing and perform computations & MATLAB coding to solve single non-linear equations	1, 6
Conduct computations & MATLAB coding to solve system of linear equations	1, 6
Conduct computations to solve system of non-linear equations	1, 6
Understand interpolation methods & perform calculations to find interpolative polynomial of data	1, 6
Understand least square method and use it to solve inconsistent system of equations, find exponential, periodic, power law, linear and nonlinear models representing data points to make predictions	1, 2, 4, 6, 7
Understand the concepts and conduct numerical integration & differentiation by coding in MATLAB	1
Understand the concepts of solving initial value problems and conduct computations and MATLAB coding to solve initial value problems	1
Understand the concepts of solving boundary value problems and conduct computations and MATLAB coding to solve initial value problems.	1

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