Title: Numerical Analysis

Number of Credits: 4

Catalog Description: Numerical solution of equations, numerical interpolation, differentiation, and integration, numerical linear algebra, numerical solution of differential equations with analysis and use of algorithms and related software. Prerequisites: CS 234 – Algorithms and Problem-Solving I and MATH 312 – Multivariable Calculus. Offered fall semesters of odd numbered years (e.g. Fall 2011, Fall 2013, etc.).

Possible Textbooks:
- Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley
- Numerical Analysis by Richard L. Burden and J. Douglas Faires

Topics Covered:

A. Numerical Computing, Computer Arithmetic and Errors
B. Solving nonlinear equations
   1. Bisection Method
   2. Linear interpolation methods
   3. Newton’s Method
   4. Fixed-point Iteration
   5. Bairstow’s Method for quadratic factors
C. Solving Systems of Linear Equations
   1. Elimination Method
   2. Gauss and Gauss-Jordan methods
   3. Determinants and Matrix Inversion
   4. Condition Numbers and Errors in Solutions
   5. Iterative Methods
   6. The Relaxation Method
   7. System of Nonlinear Equations (optional)
D. Curve Fitting Techniques
   1. Lagrangian Polynomials
   2. Divided Differences
   3. Cubic Splines
   4. Bezier curves and B-spline curves
E. Differentiation and Integration
1. Numerical Differentiation
2. Newton-Cotes Integration Formulas
3. Trapezoidal Rule
4. Simpson's Rules
5. Gaussian Quadrature
6. Adaptive Integration

F. Numerical Solutions of Ordinary Differential Equations
   1. The Taylor Series Method
   2. Euler Methods
   3. Runge-Kutta Methods - Multistep Methods
   4. Convergence and Errors
   5. Systems of Equations and Higher-Order Equations
   6. Boundary Value Problems
   7. The "Shooting Method"
   8. Solution Through a Set of Equations
   9. Derivative Boundary Conditions
   10. Eigenvalues by Iteration

G. Numerical Solutions of Partial Differential Equations
   1. Steady-state Heat Flow
   2. Laplace’s Equation on a Rectangular Region
   3. Iterative Methods for Laplace’s Equation
   4. Poisson Equation
   5. Crank-Nicolson, Theta Methods

Listing of Sections in Departmental Text to be Covered (Name and Author of Text Here):

Remarks:

Approximate Pace of Coverage:

Method of Instruction: Lecture, discussion

Evaluation Procedure: Homework, hour exams and/or quizzes, projects (including computer projects), and a final exam.

Minnesota Transfer Curriculum: Not Applicable

MnSCU Learning Outcomes:
- Students will demonstrate the ability to use numerical methods to find solutions to single nonlinear equations.
- Students will demonstrate the ability to use numerical methods to find solutions to systems of equations both linear and nonlinear.
- Students will demonstrate the ability to use curve-fitting techniques.
- Students will demonstrate the ability to use numerical methods to approximate to derivatives and definite integrals.
• Students will demonstrate the ability to use numerical methods to solve initial and boundary value problems.
• Students will demonstrate the ability to use numerical methods to solve partial differential equations.

Last Revised: Spring 2013 by the Mathematics Subgroup