MATH 451 : Numerical Methods I **(4-0-4)** 11/12/09

Catalog Description: Computer applications of matrix methods, iterative solutions of equations and systems of equations, polynomial interpolation and curve fitting, numerical differentiation and integration.

Course Objectives: After completing this course, students will be able to

1. Solve nonlinear equations with numerical methods.
2. Use numerical methods for curve fitting and approximation.
3. Perform numerical differentiation and integration of functions.
4. Solve systems of equations with numerical methods.
5. Write and interpret basic programming.

Learning Outcomes and Performance Criteria

1. Demonstrate the ability to solve nonlinear equations.
   Core Criteria:
   (a) Compute a few steps by hand and computationally implement the Bisection method.
   (b) Compute a few steps by hand and computationally implement Newton's method.
   (c) Compute the order of convergence.
   (d) Given a nonlinear equation, determine which method should be used.

   Additional Criteria:
   (a) Compute a few steps by hand and computationally implement the Secant method.
   (b) Compute a few steps by hand and computationally implement fixed point iteration.
2. Write and interpret pseudo-code and/or code using any or all of the following:
   Core Criteria:
   (a) For loops.
   (b) While loops.
   (c) Data and variable initialization.
   (d) Temporary variables.
   (e) Conditional statements.
3. Perform numerical differentiation and integration.
   Core Criteria:
   (a) Compute first order derivatives with forward and backward differences.
   (b) Compute first and second order derivatives with central differences.
   (c) Use the trapezoid method to integrate numerically.

(d) Use Simpson's method to integrate numerically.
(e) Calculate error estimations numerically.

Additional Criteria:

(a) Use Gaussian Quadrature to integrate numerically.
(b) Use the Romberg method to integrate numerically.
(c) Perform analytic error estimations for Taylor Polynomials.

4. Solve linear systems.

   Core Criteria:

   (a) Solve linear systems via Gaussian Elimination.
   (b) Solve linear systems via Gaussian Elimination with partial pivoting.
   (c) Solve linear systems via LU decomposition.
   (d) Solve linear systems via Jacobi iteration.

   Additional Criteria:

   (a) Solve linear systems via the Gauss-Seidel method..

5. Fit curves to data.

   Core Criteria:

   (a) Use a Lagrange polynomial to create an interpolating polynomial for a set of data points.
   (b) Use Newton's Divided Difference to create an interpolating polynomial for a set of data points.
   (c) Use a cubic spline to create an interpolant for a set of data points.
   (d) Use Polynomial least-squares to create an interpolating polynomial for a set of data points.

   Additional Criteria:

   (a) Use Hermite polynomial to create an interpolant for a set of data points.
   (b) Use a quadratic spline to create an interpolant for a set of data points.