MATH 452 : Numerical Methods II **(4-0-4)** 10/12/10

Catalog Description: Numerical solution of ordinary differential equations. Numerical solution of initial-value problems using Runge-Kutta methods and linear multistep methods; introduction to boundary value problems. Analysis of stability, accuracy, and implementation of methods.

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

1. Perform each of the methods given below by hand.
2. Write code to execute each of the methods given below.
3. Compute error information for numerical solutions generated by each of the methods given below.

Learning Outcomes and Performance Criteria

1. Solve first-order ordinary differential equations numerically.

   Core Criteria:

   (a) Use Euler's Method to solve a first order initial value problem.
   (b) Use the second order Runge Kutta method to solve a first order initial value problem.
   (c) Use the forth order Runge Kutta method to solve a first order initial value problem.
   (d) Use the backward Euler method to solve a first order initial value problem.
   (e) Use the Adams-Bashforth method to solve a first order initial value problem.

   Additional Criteria:

   (a) Use Heun's method to solve a first order initial value problem.
   (b) Use the Modified Euler method to solve a first order initial value problem.
   (c) Use the Adams-Moulton method to solve a first order initial value problem.

2. Solve systems of first-order ordinary differential equations.

   Core Criteria:

   (a) Compute the characteristic polynomial to find if a given method is stable.
   (b) Determine if a given system of ordinary differential equations is stiff.
   (c) Calculate the eigenvalues and eigenvectors of a matrix.
   (d) Approximate the eigenvalues of a matrix numerically by the power method.
   (e) Solve a system of initial value problems numerically with the following methods:
   Euler's Method,
   the second order Runge Kutta method,
   the fourth order Runge Kutta method.
   (f) Solve a boundary value problem numerically by the shooting method.
   (g) Solve a boundary value problem numerically by finite differences.

   Additional Criteria:

   (a) Approximate the eigenvalues of a matrix numerically by the Quadratic method.