MATH 452 Numerical Analysis II

1. Catalog Description

MATH 452 Numerical Analysis II **4 units**

Prerequisite: MATH 451.

Numerical techniques for solving partial differential equations of the parabolic, hyperbolic and elliptic type. Further topics in approximation theory. 4 lectures.

2. Required Background or Experience

Math 451 or equivalent.

3. Learning Objectives

Upon completion of this course students should:

a. Understand and be able to implement the various numerical algorithms used in solving partial differential equations, including explicit and implicit methods, and techniques for handling various boundary conditions.
b. Gain insight into the comparative results that each method has on the solution of these problems.
c. Understand how to use the software in computers and calculators to obtain numerical results for these various problems.

4. Text and References

Text to be chosen by the instructor. Suggested texts include:

- Cheney, E Ward and Kincaid, David R, Numerical Mathematics and Computing
- Kincaid, David R. and Cheney, E Ward, Numerical Analysis
- T. Sauer, Numerical Analysis
- A useful reference text: F. Acton, Real Computing Made Real: Preventing Errors in Scientific and Engineering Calculations

5. Minimum Student Materials

Access to computing equipment to allow implementation of numerical procedures and a classroom with ample chalkboard space.

6. Minimum University Facilities

Appropriate computing facilities and classroom with sufficient chalkboard space.

7. Content and Method

Content

Topics

a. Initial and Boundary Value Problems of Ordinary Differential Equations
Shooting methods, finite difference techniques, collocation, Galerkin and Rayleigh-Ritz methods, and finite element methods

b. Parabolic (heat-diffusion) equations
Explicit and implicit methods, Crank-Nicolson method, forward and backward differences, mildly nonlinear problems, and using various boundary conditions. Galerkin's method and finite elements.

c. Elliptic (Laplace and Poisson) equations
Solution of boundary value problems (the Dirichlet problem on simple and complex domains), finite difference techniques, iterative methods (Jacobi's, Gauss-Seidel, and SOR), and mildly nonlinear problems. Galerkin's method and finite Elements.

d. Hyperbolic (wave) equations
Finite difference methods, d'Alembert's solution, method of characteristics, and additional explicit and implicit methods

e. Additional Topics
Difference equations; Galerkin's method; finite elements; best approximations.

8. Methods of Assessment

Comprehensive final exam, mid-term exams or quizzes, homework.