

Fall

2007

Numerical Analysis I

MATH 401, Section 01

INSTRUCTOR: Dr. Ming Fang

CLASS MEETINGS: 3:00-4:15pm Tuesday and Thursday. C226 Brown Memorial Hall

OFFICE LOCATION: B-181 Brown Memorial Hall

PHONE: 823-8867

E-MAIL: mfang@nsu.edu (preferred)

WEBSITE: <http://math.nsu.edu/mfang>

OFFICE HOURS: MWF 9:00-10:00am, Tuesday 9:30-12:30pm, 2:00-3:00pm, and Thursday 2:00-3:00pm or by appointments.

COURSE DESCRIPTION: An introduction to numerical techniques for problem solving involving the use of computers. The topics include error analysis, convergence, solution of one variable equations, solution of linear and nonlinear systems of equations, iterative techniques in matrix algebra, and approximating eigenvalues.

PREREQUISITES: Completion of Calculus II (MTH 251), Linear Algebra (MTH 300), and a Programming Language with a minimum grade of "C".

COURSE RATIONALE:

Computers are playing an increasingly important role in any mathematics, science and engineering curriculum. There has been a dramatic increase in computer literacy among the undergraduate population. The flip side of this development is the enormous confidence the students have in the computers and the results they give.

A course in numerical analysis is the key to developing accurate and robust algorithms in mathematics, sciences, engineering, etc.. This course begins to reveal the methods of numerical computation; their strengths, their shortcomings, the nature of their approximations, their errors, and their appropriate applications. The course also introduces students to some of the more advanced methods of numerical computation, which may not be currently implemented on hand-held computing devices.

GOALS & MEASURABLE INTENDED STUDENT LEARNING OUTCOMES: By attending the lectures, completing the assignments, and participating in class, the student should accomplish the following general goals:

1. Gain experience in modern approximation techniques.
2. Explain how, why, and when the techniques can be expected to work.
3. Gain a firm basis for future study in numerical analysis.
4. Explore various existing software packages.
5. Understand the issues of scientific programming from algorithms.

Upon completion of this course, students should be able to perform the following materials at a 70% or better mastery level.

1. Round-off Errors and Computer Arithmetic
2. Solutions of Equations in One Variable

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- a. The Bisection Method
- b. Fixed-Point Iteration
- c. The Newton-Raphson Method
- d. Error Analysis for Iterative Methods
- e. Zeros of Polynomials
3. Direct Methods for Solving Linear Systems
 - a. Pivoting Strategies
 - b. Matrix Factorization
 - c. Special Types of Matrices
4. Iterative Techniques in Matrix Algebra
 - a. Norms of Vectors and Matrices
 - b. Convergence of Iterative Methods
 - c. Iterative Techniques for Solving Linear Systems
5. Newton's Method to Solve Nonlinear Systems of Equations

COURSE MATERIALS/REQUIREMENTS/ REQUIRED TEXT:

Each student must:

1. prepare for each lecture by reading the appropriate topic(s).
2. devote a minimum of 6 hours per week for preparation.
3. attend all lectures and keep a notebook of lecture notes and solved problems.
4. complete and turn in all assignments on time.
5. have a graphing calculator.

Text: *Numerical Analysis*: Burden and Faires; PWS-KENT Publishing, 8th Edition (2005).

Calculators: Graphing calculators are recommended.

Computer Resources: 1. MATLAB¹ 2. MAPLE² 3. MATHEMATICA 4. FORTRAN 5. C/C++

Course Credits: 3 Credits - 3 Lecture Hours

COURSE OUTLINE:

- A. Chapter 1: Mathematical Preliminaries
 1. Review of Calculus
 2. Round-off Errors and Computer Arithmetic
 3. Algorithms and Convergence

¹ Please contact Mr. Michael L. Williams or Mr. Krish Agarwal in Engineering department at (757) 823-2838 to set up your MATLAB account. They are located in Robinson Tech building.

² MAPLE is available in **BMH C227**, STARS tutorial site, etc..

- B.** Chapter 2: Solutions of Equations In One Variable
1. The Bisection Method
 2. Fixed-Point Iteration
 3. The Newton-Raphson Method
 4. Error Analysis for Iterative Methods
 5. Accelerating Convergence
 6. Zeros of Polynomials
- C.** Chapter 6: Direct Methods for Solving Linear Systems
1. Linear Systems of Equations
 2. Pivoting Strategies
 3. Linear Algebra and Matrix Inversion
 4. The Determinant of a Matrix
 5. Matrix Factorization
 6. Special Types of Matrices
- D.** Chapter 7: Iterative Techniques in Matrix Algebra
1. Norms of Vectors and Matrices
 2. Eigenvalues and Eigenvectors
 3. Iterative Techniques for Solving Linear Systems
 4. Error Estimates and Iterative Refinement
- E.** Chapter 9: Approximating Eigenvalues
1. Linear Algebra and Eigenvalues
 2. The Power Method
 3. Householder's Method
 4. The QR Algorithm
- F.** Chapter 10: Numerical Solutions of Nonlinear Systems of Equations
1. Fixed Points for Functions of Several Variables
 2. Newton's Method

RELATED UNIVERSITY-WIDE AND COURSE- SPECIFIC REQUIREMENTS

- **Writing:** The student will have a number of computer project in which there will be reports completed. There are open-ended questions where the student will write the explanation/answer.
- **Information Technology Literacy:** Students are encouraged to communicate (outside of class) with the professor or classmates through electronic means. Matlab and Maple can be used effectively for projects in this course. You are required to explore various websites to gain a better understanding of those software because they are a secondary technology.
- **Quantitative Reasoning:** Most of the math concepts have applications that require quantitative reasoning.
- **Scientific Reasoning:** Most of the math applications require the use of scientific

reasoning.

- **Oral Communication:** The student demonstrates this through classroom discussions and explanations at the board.
- **Critical Thinking:** Most of the math concepts and applications require critical thinking.

EVALUATION: Course grades are determined as follows:

Exams	100 points
Homework and Quizzes	100 points
Computer Assignments	100 points
Total	300 points

GRADING STANDARDS:

The following grades are guaranteed if you earn the corresponding percentage of the total points by the end of the semester:

90-100%	87-89%	84-86%	80-83%	77-79%	74-76%
A	A-	B+	B	B-	C+
70-73%	67-69%	64-66%	60-63%	57-59%	Below 56%
C	C-	D+	D	D-	F

The instructor reserves the right to revise the grading criteria as appropriate and will make reasonable attempts to notify students as time permits.

ACADEMIC INTEGRITY POLICIES: You are expected and encouraged to discuss problems with others; students often learn best from other students. However, the work you turn in should be completely your own. **Cheating during an exam will be penalized by disciplinary referral and grade penalty for all involved parties.**

AMERICANS WITH DISABILITIES ACT (ADA) STATEMENT

In accordance with section 504 of the 1973 Rehabilitation Act and the Americans with Disabilities Act (ADA) of 1990, if you have a disability or think you have a disability please make contact with Supporting Students through Disability Services (SSDS) Office.

Location: 2nd floor/Lyman B. Brooks Library, Room 240

Contact Person: Marin E. Shepherd, Disability Services Coordinator

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Telephone: 823-2014

UNIVERSITY ASSESSMENT STATEMENT

As part of NSU's commitment to provide the environment and resources needed for success, student may be required to participate in a number of university-wide assessment activities. The activities may include tests, surveys, focus groups and interviews, and portfolio reviews. The primary purpose of the assessment activities is to determine the extent to which the university's programs and services maintain a high level of quality and meet the needs of the students. Students will not be identified in the analysis of results. Unless indicated otherwise by the instructor, results from University assessment activities will not be computed in the student grades.

