

**SPRING 2007**  
**MTH 402.01 – NUMERICAL ANALYSIS II (3 credit hours)**  
**TTH 1:30-3:00PM BMH C-233**

**Instructor:** Dr. Ming Fang, Assistant Professor

**Location:** BMH B-181

**Phone Number:** 823-8867

**E-mail:** [mfang@nsu.edu](mailto:mfang@nsu.edu) (preferred)

**Office Hours:** 2:00-4:00pm, Monday; 8:00-9:30am Tuesday and Thursday; 1:00-4:00pm,  
Wednesday

**Math Dept.** BMH B168 **Phone:** 823-8820

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**Course Description:**

A continuation of MTH 401. Topics include polynomial interpolation and approximation, numerical differentiation and integration, approximation theory, and numerical approaches to ordinary and partial differential equations..

**Prerequisite:** (MTH 401) Numerical Analysis I

**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 numerical differentiation, integration techniques, numerical approaches to ordinary and partial differential equations.
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 materials listed in Course Outline at a 70% or better mastery level.

### **Course Materials/Requirements/ Required Text:**

Each student must:

1. Attend lectures/demonstrations as I may have you work on problems that are handed in *class*. These problems may be **collected and graded** as the bonus part of homework. If you are absent, you will not have the opportunity to complete the problems. Therefore, attendance is very important to your success in this course. There are other reasons for attending class. For example, my exam questions will (for the most part) reflect the examples that I complete in class. **You are responsible for keeping current with *what is covered in class*--not necessarily just what is in the book.**
2. Complete assignments as scheduled by the instructor;
3. Read textbook.

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

**Calculators:** Graphing calculators are recommended.

**Computer Resources:** 1. MAPLE<sup>1</sup> 2. MATLAB<sup>2</sup> 3. MATHEMATICA 4. FORTRAN 5. C/C++

### **Primary Method(s) of Instruction / Methods to Engage Students:**

- 1) 3 hour lecture and discussion
- 2) Homework assignments, quizzes, exams
- 3) MATLAB Projects

### **Course Outline:**

Chapter 3: Interpolation and Polynomial Approximation  
Section 3.1: Interpolation and the Lagrange Polynomial  
Section 3.2: Divided Difference  
Section 3.3: Hermite Interpolation  
Section 3.4: Cubic Spline Interpolation

Chapter 4: Numerical Differentiation and Integration  
Section 4.1: Numerical Differentiation  
Section 4.2: Richardson's Extrapolation  
Section 4.3: Elements of Numerical Integration  
Section 4.4: Composite Numerical Integration  
Section 4.7: Gaussian Quadrature  
Section 4.9: Improper Integrals

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<sup>1</sup> MAPLE is available in **BMH C227**, STARS tutorial site, etc..

<sup>2</sup> 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 the first floor of Norfolk Community Hospital.

Chapter 5: Initial-Value Problems for Ordinary Diff. Equations

Section 5.1: The Elementary Theory of Initial-Value Problems

Section 5.2: Euler's Method

Section 5.3: Higher-Order Taylor Methods

Section 5.4: Runge-Kutta Methods

Section 5.5: Error Control and the Runge-Kutta-Fehlberg Method

Section 5.6: Multistep Methods

Section 5.7: Variable Step-Size Multistep Methods

Section 5.8: Extrapolation Methods

Section 5.9: Higher-Order Equations and Systems of Diff. Equations

Chapter 8: Approximation Theory

Section 8.1: Discrete Least Squares Approximation

Section 8.2: Orthogonal Polynomials and Least Squares Approximation

Section 8.3: Chebyshev Polynomial and Economization of Power Series

Section 8.5 Trigonometric Polynomial Approximation

Section 8.6 Fast Fourier Transforms

Chapter 11: Boundary-Value Problems for Ordinary Diff. Equations

Section 11.1: The Linear Shooting Method

Section 11.2: The Shooting Method of Nonlinear Problems

Section 11.3: Finite-Difference Methods for Linear Problems

Section 11.4: Finite-Difference Methods for Nonlinear Problems

Chapter 12: Numerical Solutions to Partial Diff. Equations

Section 12.1: Elliptic Partial Diff. Equations

Section 12.2: Parabolic Partial Diff. Equations

Section 12.3: Hyperbolic Partial Diff. Equations

*The outline is subject to change at the discretion of the instructor or depending upon the progress of the class.*

**Related University-Wide and Course- Specific Requirements**

- **Writing:** The student will have a number of computer project in which there will be reports completed.
- **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:

Homework and quizzes	100
Computer Projects	50
2 exams	100
Total	250

**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.*

Class Policies And Procedures:

1. **Make-up Tests/Quizzes.** Tests can be made up with a valid excuse and **PRIOR** to the return of the Test/Quiz papers (usually before the next class period).
2. **Cheating of any kind will not be tolerated and will result in an automatic grade of “F” for the semester (further disciplinary actions may be taken by the university).**

**ACADEMIC INTEGRITY POLICIES:**

Students are expected to attend all class sessions. Further information regarding academic or academically related conduct and disciplinary procedures and sanctions regarding misconduct may be obtained by consulting the NSU Student Handbook.

### **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:** 2<sup>nd</sup> floor/Lyman B. Brooks Library, Room 240

**Contact Person:** Marin E. Shepherd, Disability Services Coordinator

**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.