湖北工業大學
HUBEI UNIVERSITY OF TECHNOLOGY

Course Title	Numerical Methods
Course Code	MATH 4251
Semester	Summer 2026
Course Length	4 Weeks, 60 Contact Hours
Credits	4
Instructor	TBA
Office	TBA
Email	TBA
Prerequisite	CMPT 1011 Introduction to Computer Science MATH 2151 Linear Algebra I MATH 2231 Multivariable Calculus MATH 2311 Differential Equations

Course Description:

This course introduces the fundamental techniques and theoretical principles used in numerical computation for solving mathematical problems that arise in science, engineering, and data analysis. Students learn how to construct, analyze, and implement algorithms to approximate solutions of nonlinear equations, integrals, differential equations, and systems of linear equations. Emphasis is placed on understanding sources of error, algorithmic stability, convergence, and computational efficiency. Practical exercises using MATLAB reinforce the connection between mathematical theory and computational practice.

Course Goals:

Students who successfully complete this course will demonstrate competency in the following general education core goals:

- **Critical Thinking Skills** – Students will engage in analytical thinking, demonstrating the ability to critically evaluate, synthesize, and apply knowledge to complex problems, and construct well-reasoned solutions and arguments.
- **Independent Research and Inquiry** – Students will conduct independent research, utilizing academic resources to explore relevant topics, formulating research questions, analyzing data, and presenting findings in a coherent, scholarly manner.
- **Problem-Solving and Application** – Students will apply theoretical concepts and methodologies learned in the course to real-world problems, demonstrating the ability to develop practical solutions informed by academic inquiry.
- **Global and Cultural Awareness** – Students will gain awareness of the global and cultural contexts relevant to the course, appreciating diverse perspectives

and considering the implications of their studies in a broader, international context.

Student Learning Outcomes:

Upon completion of this course, students will be able to:

- Explain the nature of numerical errors and assess algorithmic stability and convergence;
- Apply numerical techniques to approximate roots, integrals, and derivatives;
- Implement direct and iterative algorithms to solve systems of linear equations and eigenvalue problems;
- Employ interpolation and polynomial approximation methods to model data;
- Utilize numerical integration and differentiation to analyze continuous systems;
- Apply numerical methods for ordinary differential equations (ODEs) and understand the stability of solutions;
- Evaluate algorithm performance and accuracy using real-world data or modeling applications.

Textbooks/Supplies/Materials/Equipment/ Technology or Technical Requirements:

Primary Textbook:

Numerical Analysis (9th edition), by Richard L. Burden and J. Douglas Faires, Cengage Learning.

Supplementary Textbooks:

Numerical Methods: Using MATLAB (3rd edition), by George Lindfield and John Penny, Academic Press.

Numerical Methods in Scientific Computing, Volume 1, by Germund Dahlquist and Åke Björck, SIAM Publications.

There is no class specified language, but the instructor uses (mostly) MATLAB.

Course Requirements:

Mini Quizzes (10%)

Short in-class, paper-based quizzes and coding exercises reinforce lecture concepts and encourage consistent engagement.

Homework Assignments (30%)

Students complete regular assignments combining written exercises and programming tasks. Each assignment emphasizes applying theoretical methods to computational problems such as root-finding, interpolation, or solving ODEs. Submissions include code, explanations, and short error analyses. Collaboration on ideas is allowed, but submitted work must be individual.

Software and Programming Component

For computational problems, students are free to use Python, MATLAB (recommended), or even FORTRAN. Each homework includes computational exercises such as:

- Implementing Newton's method with error tracking;
- Constructing cubic spline interpolations;
- Computing integrals using adaptive quadrature;

- Solving ODEs via Runge-Kutta methods;
- Solving large linear systems with iterative methods.

Midterm Exams (30%)
Two invigilated, in-person exams test conceptual understanding and analytical problem-solving skills. Students demonstrate their ability to derive, analyze, and evaluate numerical algorithms. Midterms are closed-book but allow one formula sheet to emphasize comprehension over memorization.

Final Exam (30%)
The final exam is a cumulative, in-person assessment held during the university's examination period, assessing both theory and application. It includes a mix of written problems and short computational questions testing implementation logic and algorithmic accuracy.

Assessments: Activity	**Percent Contribution**
Mini Quizzes	10%
Homework Assignments	30%
Midterm Exams (2)	30% total - 15% each
Final Exam	30%

Grading:

Final grades will be based on the sum of all possible course points as noted above.

Grade	**Percentage of available points**
A	94-100
A-	90-93
B+	87-89
B	84-86
B-	80-83
C+	77-79
C	74-76
C-	70-73
D	64-69
D-	60-63
F	0-59

Course Schedule:
The schedule of activities is subject to change at the reasonable discretion of the instructor. Minor changes will be announced in class, major ones provided in writing.

MATH 4251 Schedule		
Lecture	Topic	Readings
L1	Course introduction; motivation; types of numerical errors (round-off, truncation); algorithmic convergence	Ch. 1.1 - 1.3
L2	Floating-point arithmetic and round-off error propagation; assessing numerical stability	Ch. 1.2 - 1.4
L3	Solving nonlinear equations: bisection, fixed-point iteration, Newton's method	Ch. 2.1 - 2.3

L4	Convergence criteria and error bounds for iterative methods	Ch. 2.4 - 2.5
L5	Zeros of polynomials, convergence acceleration, and practical implementation	Ch. 2.6 - 2.7
L6	Interpolation theory and Lagrange polynomials	Ch. 3.1
L7	Divided differences and Newton's interpolation formula	Ch. 3.2
L8	Hermite and cubic spline interpolation; curve fitting	Ch. 3.3 - 3.5
L9	Numerical differentiation and Richardson extrapolation	Ch. 4.1 - 4.2
L10	Numerical integration: Trapezoidal and Simpson's rules	Ch. 4.3 - 4.4
L11	Composite and adaptive quadrature methods; Gaussian quadrature	Ch. 4.5 - 4.7
L12	Solving initial value problems for ODEs: Euler and Taylor methods	Ch. 5.1 - 5.3
L13	**Midterm Exam 1 (Lectures 1-10)**	/
L14	Runge-Kutta and multistep methods; error control and step-size adaptation	Ch. 5.4 - 5.7
L15	Solving linear systems: Gaussian elimination, pivoting, and LU factorization	Ch. 6.1 - 6.5
L16	Matrix conditioning and special matrix types	Ch. 6.6
L17	Iterative methods: Jacobi, Gauss-Seidel, and SOR methods	Ch. 7.3 - 7.4
L18	Conjugate gradient method and convergence analysis	Ch. 7.5
L19	Eigenvalue problems: power method, Householder transformations, QR algorithm	Ch. 9.2 - 9.4
L20	Least squares approximation and orthogonal polynomials	Ch. 8.1 - 8.2
L21	Fast Fourier Transform (FFT) and applications	Ch. 8.6
L22	Multivariable nonlinear equations and Newton's method in higher dimensions	Ch. 10.1 - 10.3
L23	**Midterm Exam 2 (Lectures 11-20)**	/
L24	Boundary value problems: shooting and finite difference methods	Ch. 11.1 - 11.4
L25	Introduction to numerical PDEs: finite difference methods for elliptic and parabolic equations	Ch. 12.1 - 12.3
/	**Final Exam (Cumulative)**	/

Accommodation Statement:

Academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as he/she is not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow.

Academic Integrity Statement

Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in coursework may receive a reduced or failing grade for the work in question and/or for the course.

Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional

qualifications within or outside the University; and nondisclosure or misrepresentation in filling out applications or other University records.

Other Items:

Attendance and Expectations
All students are required to attend every class, except in cases of illness, serious family concerns, or other major problems. We expect that students will arrive on time, be prepared to listen and participate as appropriate, and stay for the duration of a meeting rather than drift in or out casually. In short, we anticipate that students will show professors and fellow students maximum consideration by minimizing the disturbances that cause interruptions in the learning process. This means that punctuality is a must, that cellular phones be turned off, and that courtesy is the guiding principle in all exchanges among students and faculty. You will be responsible for the materials and ideas presented in the lecture.

Assignment Due Dates
All written assignments must be turned in at the time specified. Late assignments will not be accepted unless prior information has been obtained from the instructor. If you believe you have extenuating circumstances, please contact the instructor as soon as possible.

Make-Up Work
The instructor will not provide students with class information or make-up assignments/quizzes/exams missed due to an unexcused absence. Absences will be excused and assignments/quizzes/exams may be made up only with written documentation of an authorized absence. Every effort should be made to avoid scheduling appointments during class. An excused student is responsible for requesting any missed information from the instructor and setting up any necessary appointments outside of class.

Access, Special Needs, and Disabilities
Please notify the instructor at the start of the semester if you have any documented disabilities, a medical issue, or any special circumstances that require attention, and the school will be happy to assist.