



湖北工业大学
HUBEI UNIVERSITY OF TECHNOLOGY

Course Title	Ordinary Differential Equations
Course Code	MATH 3121
Semester	Summer 2026
Course Length	4 Weeks, 60 Contact Hours
Credits	4
Instructor	Wang Mei
Office	NO.2 Teaching Building B206
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Prerequisite	MATH 2151 Linear Algebra I MATH 2231 Multivariable Calculus

Course Description:

This course provides a comprehensive introduction to the theory, solution techniques, and modeling applications of ordinary differential equations (ODEs). Designed for undergraduate students in mathematics, physics, and quantitative engineering disciplines, the course balances analytical techniques with numerical approximations and qualitative geometric analysis. Students will investigate first- and second-order linear and nonlinear equations, integral transform methods, systems of simultaneous differential equations, and power series solutions. Additionally, the course introduces boundary-value problems, eigenvalue approximations, and foundational orthogonal expansions, enabling students to formulate and analyze mathematical models of dynamic physical phenomena.

Delivery Mode: In-Person, Face-to-Face Instruction

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 creative and/or innovative thinking, and/or inquiry, analysis, evaluation, synthesis of information, organizing concepts, and constructing solutions.
- **Communication skills** – Students will demonstrate effective written, oral, and visual communication.
- **Teamwork** – Students will demonstrate the ability to work effectively with others to support a shared purpose or goal and consider different points of view.
- **Social responsibility** – Students will demonstrate intercultural competency and civic knowledge by engaging effectively in local, regional, national, and global communities.

Student Learning Outcomes:

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

- Identify, classify, and solve foundational classes of first- and second-order ordinary differential equations using analytical methods;
- Apply qualitative geometric techniques, including phase-line and phase-plane analysis, to determine the stability and long-term behavior of nonlinear dynamical systems;
- Employ Laplace transforms to solve continuous and piecewise-continuous initial-value problems;
- Construct power series and Frobenius solutions for second-order linear equations near ordinary and regular singular points;
- Solve autonomous linear systems of ODEs using matrix methods and eigenanalysis;
- Formulate mathematical models for physical, biological, and engineering systems and solve them numerically using computational algorithms.

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

Primary Text: William E. Boyce, Richard C. DiPrima, Douglas B. Meade. *Elementary Differential Equations and Boundary Value Problems, 12th Edition*. Wiley. (Referred to as *BD*)

Supplementary Text: Steven H Strogatz. *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, 3rd Edition*. CRC Press. (Referred to as *NDC*)

Computational Software: Students must have access to a programming environment such as MATLAB or Python.

Course Requirements:**Midterm and Final Examinations (50% total)**

The examination block consists of one Midterm Examination (20%) and a cumulative Final Examination (30%). These written assessments assess students' grasp of theoretical existence theorems, structural properties of differential operators, and analytical calculation mastery. Exam questions emphasize algebraic derivations, exact solving methods, and conceptual proofs under standard timed testing conditions.

Weekly Homework Assignments (20%)

Problem sets are assigned weekly to reinforce analytical derivation skills and algebraic practices. These tasks require clear mathematical prose, logical deduction steps, and manual solutions to characteristic problems.

Computational Modeling Assignments (15%)

Students will complete two independent algorithmic data labs using MATLAB or Python. These assignments connect abstract calculus with real-world calculation by requiring students to construct primitive differential equations solvers, map local and

global truncation errors, and visually generate phase portraits for coupled multi-variable systems.

Applied Mathematics Project (15%)

Students will complete a small project involving the formulation, analysis, or simulation of a differential equation model from an applied context such as population dynamics, mechanics, epidemiology, electrical circuits, or heat transfer. A short written report is required.

Assessments: Activity	Percent Contribution
Midterm and Final Examinations	50%
Weekly Homework Assignments	20%
Computational Modeling Assignments	15%
Applied Mathematics Project	15%

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 3121 Schedule		
Lecture	Topic	Readings
L1	Introduction to differential equations; mathematical models; direction fields; classification of ODEs	BD 1.1-1.3
L2	First-order linear equations and integrating factors	BD 2.1
L3	Separable equations and applications	BD 2.2-2.3
L4	Nonlinear equations; autonomous equations and population models	BD 2.4-2.5
L5	Exact equations and integrating factors	BD 2.6
L6	Existence, uniqueness, and qualitative behavior of solutions	BD 2.8; NDC 2.1-2.5
L7	Numerical approximations: Euler method and improved Euler method	BD 2.7; 8.1-8.2
L8	Runge-Kutta methods; error and stability concepts	BD 8.3; 8.6
L9	Bifurcations and qualitative changes in dynamical systems	NDC 3.1-3.4

L10	Second-order linear equations with constant coefficients <i>Computational Assignment 1 Due</i>	<i>BD 3.1-3.3</i>
L11	Repeated roots, reduction of order, and Wronskian methods	<i>BD 3.2-3.4</i>
L12	Nonhomogeneous equations: undetermined coefficients and variation of parameters	<i>BD 3.5-3.6</i>
L13	Mechanical vibrations and resonance phenomena	<i>BD 3.7-3.8</i>
--	Midterm Exam	Covers L1-13
L14	Higher-order linear differential equations	<i>BD 4.1-4.4</i>
L15	Laplace transforms and inverse transforms	<i>BD 6.1-6.2</i>
L16	Discontinuous forcing, impulse functions, and convolution ideas	<i>BD 6.3-6.6</i>
L17	Introduction to systems of first-order equations; matrix formulation	<i>BD 7.1-7.4</i>
L18	Eigenvalues, eigenvectors, and homogeneous linear systems	<i>BD 7.5-7.8</i>
L19	Nonhomogeneous systems and phase-plane analysis <i>Computational Assignment 2 Due</i>	<i>BD 7.9; NDC 5.1-5.3; 6.1-6.3</i>
L20	Nonlinear systems; stability; predator-prey and competing species models	<i>BD 9.2-9.5; NDC 6.4-6.7</i>
L21	Power series review and ordinary-point series solutions	<i>BD 5.1-5.3</i>
L22	Euler equations; regular singular points; Frobenius methods	<i>BD 5.4-5.6</i>
L23	Bessel equations and special-function solutions	<i>BD 5.7</i>
L24	Boundary-value problems and Fourier series <i>Project Report Due</i>	<i>BD 10.1-10.4; 11.1-11.2</i>
L25	Separation of variables; introductory heat and wave equations; comprehensive review	<i>BD 10.5-10.7</i>
--	Final Exam	Above all

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 without 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 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.