ILLINOIS

Math 285: Differential Equations

Offered through NetMath

Academic Year 2026-2027 Term, 16-week course

Instructor Information

Instructor – ***Tayyab Nawaz***

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- Office hours by appointment.

Course Information

Credit Hours

3 credit hours

Course Description

MATH 285 is a rigorous, application-driven introduction to ordinary and partial differential equations, designed to develop both analytical skill and physical intuition. Students build proficiency in solving a wide range of differential equations that arise throughout STEM disciplines, progressing from classical solution techniques to modern tools including the Laplace transform, matrix exponentials, and Fourier analysis. Key topics include separable and exact equations, integrating factors, autonomous equations and stability, the existence and uniqueness theorem, second-order linear ODEs with constant coefficients, the method of undetermined coefficients, variation of parameters, Cauchy–Euler equations, Laplace transforms with piecewise and periodic forcing, systems of ODEs and phase plane analysis, Fourier sine and cosine series, boundary value problems, and the heat and wave equations with Dirichlet and Neumann boundary conditions. Intended primarily for engineering majors and others who require a working knowledge of differential equations.

Prerequisite

MATH 241

Course Objectives:

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

1. Understand how differential equations arise in STEM contexts and apply them to modeling real-world phenomena using first-order ODEs.
2. Solve first-order ordinary differential equations using separation of variables, integrating factors, and exact equation techniques, and analyze autonomous equations for stability and bifurcations.
3. Apply the existence and uniqueness theorem, superposition principle, and Wronskian to characterize the solution space of higher-order linear ODEs.
4. Solve second-order and higher-order linear ODEs with constant coefficients using characteristic polynomials, and find particular solutions via the method of undetermined coefficients and variation of parameters.
5. Apply the Laplace transform and its inverse to solve initial value problems, including equations with piecewise-continuous and periodic forcing functions.
6. Solve systems of first-order ODEs using matrix exponentials and eigenvalue analysis, and classify the stability of equilibria using phase plane methods.
7. Apply Fourier sine and cosine series to represent functions and solve boundary value problems arising in the heat equation and wave equation.
8. Solve the heat equation and wave equation with Dirichlet and Neumann boundary conditions using separation of variables and Fourier series.

Course Content:

1. **Introduction to differential equations:** Classification by order and linearity, examples from physics and engineering, initial value problems, solving by direct integration, separable equations, and exponential growth and decay models.
2. **First-order equations:** Integrating factors for linear first-order ODEs, exact equations and potential functions, autonomous equations and fixed points, stability analysis, bifurcations, and numerical methods (Euler, improved Euler, Runge–Kutta).
3. **Linear theory and the Wronskian:** Existence and uniqueness theorem, superposition principle for linear ODEs, linear independence of solutions, the Wronskian determinant, and construction of general solutions from independent solutions.
4. **Second-order linear ODEs with constant coefficients:** Characteristic polynomial, real and complex roots, Euler’s formula and complex exponentials, repeated roots, differential operators, and the fundamental theorem of algebra applied to higher-order equations.
5. **Methods for nonhomogeneous ODEs:** Method of undetermined coefficients for polynomial, trigonometric, and exponential forcing; variation of parameters; Cauchy–Euler equations; and reduction of order for higher-order and variable-coefficient equations.

6. **Laplace transforms:** Definition and properties of the Laplace transform, common transform pairs, inverse Laplace transform via partial fractions, convolution theorem, and solving initial value problems with piecewise-continuous and periodic forcing using the unit step function.
7. **Systems of first-order ODEs and phase plane analysis:** Matrix form of linear systems, eigenvalues and eigenvectors of coefficient matrices, matrix exponential and diagonalization, nonhomogeneous systems via variation of parameters, phase portraits, classification of critical points (node, saddle, spiral, center), and linearization of nonlinear systems.
8. **Orthogonality, eigenvalue problems, and Fourier series:** Boundary value problems and the Sturm–Liouville framework, orthogonality of eigenfunctions, Fourier sine and cosine series on [0, L], convergence for piecewise smooth functions, and orthogonal decomposition of initial data.
9. **Partial differential equations:** Separation of variables for the heat equation and wave equation, Dirichlet and Neumann boundary conditions, Fourier series solutions to initial–boundary value problems, and the method of images for special domain geometries.

Course Structure:

This course is fully online and asynchronous. Students have 16 weeks from their course start date to complete the course. The course is self-paced, and students may complete their coursework prior to the assigned end date. However, students are encouraged to follow the guided structure provided by the instructor with suggested deadlines for assignments and exams. As this is a 3-credit hour course, students are expected to dedicate 9 hours per week to learning course content.

The course expects students to complete roughly one unit per week across the 16-week self-paced period. Assessments include quizzes (10%), worksheets (10%), PrairieLearn homework (15%), three midterm exams (15% each), and a final exam (20%), with all exams proctored online through ProctorU Record+.

Course Platforms:

Platform	Description
Canvas	Course materials, announcements, grades, and lecture notes
PrairieLearn	Homework assignments, quizzes, and computational exercises
ProctorU	All exams administered online via ProctorU Record+

Exams:

The course consists of 14 units, each containing assessment work such as homework, worksheets, and quizzes.

Information	Exam 1	Exam 2	Exam 3	Final Exam
Coverage:	Unit 1-4	Unit 5-8	Unit 9-12	Comprehensive
Time Limit:	55 Minutes	55 Minutes	55 Minutes	3 Hours

All exams will be administered online, free of charge to students. Exams are administered using ProctorU Record+. More information on taking exams.

Calculators are not permitted or required for NetMath exams.

The use of outside sources is prohibited.

Refer to the Academic Integrity policies below in the syllabus for more details.

Scratch paper is allowed during exams.

Exams must be taken in course order.

Grading:

Grading Breakdown:

Component	Weight
Worksheets	7%
PrairieLearn Homework	10%
Quizzes	8%
Exam 1	15%
Exam 2	15%
Exam 3	15%
Final Exam	30%

Letter Grade Scale:

Percentage	Letter Grade
97 - 100	A+
93 - 96	A
90 - 92	A-
87 - 89	B+
83 - 86	B
80 - 82	B-
77 - 79	C+
73 - 76	C
70 - 72	C-
67 - 69	D+
63 - 66	D
60 - 62	D-
59 and below	F

Final grades are rounded to the nearest integer before applying the scale above.

Grades are not curved.

Once you complete your exam, you will receive a 0 on any homework leading up to that exam that has not been submitted. Under special circumstances, students may request that they be allowed to submit these assignments. This is left to the discretion of the course instructor.

Students are encouraged to follow the guided deadlines in their course. However, as our courses are self-paced, students may submit several assignments in a short period of time.

Due to the rolling enrollment structure of the NetMath program, instructor workloads vary throughout the year. During peak periods, response times may be longer than usual. Students should expect significant delays in instructor responses between June and August.

Communication:

Students are encouraged to post course-related questions on the Canvas forum, so all students can benefit from the responses, and it fosters a collaborative learning environment. For private or personal matters, students can contact the instructor directly via email, with a response time of 2–3 business days.

If you experience consistent and significant delays in reaching your instructor, please contact instruction@netmath.illinois.edu with your concerns.

If you have non-course specific questions, you may reach out to the NetMath office. It is recommended to review the NetMath website first as it often has the answers you need.

General Inquiries: netmath@illinois.edu

Proctoring Questions: proctor@netmath.illinois.edu

Technology Questions: tech-staff@netmath.illinois.edu

Main Office Phone: (217) 265-0439

Phone hours: Monday - Friday, 9am - 12pm & 1pm - 4pm CST

Textbook:

There is no required textbook. All lecture notes, readings, and reference materials are provided through Canvas. Students who wish to supplement their learning may find the following resources helpful:

– Differential Equations by Bill Davis, Horacio Porta and Jerry Uhl (free course textbook, available via Canvas)

Technical Requirements:

Students are expected to have a device with an up-to-date operating system to access their course materials, reliable internet access, and must meet the requirements set by ProctorU for exam proctoring. NetMath IT - Frequently Asked Questions.

Other Information:

Course content is drawn from Differential Equations written by Bill Davis, Horacio Porta and Jerry Uhl © 2006–2010.

Policies:

Accommodations:

The University of Illinois Champaign-Urbana, is committed to ensuring that all students, including students with disabilities, do not experience barriers to learning and participating fully in class. Students who have a letter of accommodation from DRES are advised to share that with their instructor and NetMath staff at instruction@netmath.illinois.edu as soon as possible to ensure accommodation needs can be discussed and met.

Students enrolled in a degree program at another institution may refer to their home institution's student services or disability office for accommodations. Current, non-expired documentation from other institutions listing the specifics of an accommodation is acceptable and should be sent to instruction@netmath.illinois.edu.

To obtain disability-related academic accommodations, disabled students must contact Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, please visit 1207 S. Oak Street, Champaign, call (217) 333-1970, email disability@illinois.edu, or visit the DRES website.

Academic Integrity:

The University of Illinois Urbana-Champaign *Student Code* (https://studentcode.illinois.edu/) should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy (https://studentcode.illinois.edu/article1/part4/1-401/). Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

AI Large Language Models (such as ChatGPT, Claude, Gemini, etc.) are prohibited during exams. Using these during the exam will be considered a violation of academic integrity and may incur sanctions as outlined in the Illinois Student Code. Students should be aware the exam proctoring process involves screen recording of the computer. While AI will not be strictly prohibited for homework as they can be useful tools for studying and brainstorming, students are strongly encouraged to work on the homework themselves or collaborate with peers when appropriate. Students are required to submit their own work and answers. This improves learning outcomes and best prepares students for exams. Homework is designed to help students understand the content and develop skills. Students may be unprepared for exams if there is heavy reliance on AI.

Students are expected to follow the University guidance on intellectual property. Students are not to share course content outside of the course.

Campus Holidays:

Instructors are expected to respond to student communications and grade homework assignments in a timely manner. Observed Campus Holidays, illness, personal obligations, or other circumstances outside the instructor's control may affect normal grading and response time. If you experience consistent and significant delays, please contact instruction@netmath.illinois.edu with your concerns.

Extensions:

Students in this course are eligible for up to two 1-month course extensions. There is a non-refundable $350 fee for each approved extension. Students should review the extension guidelines for more information.

FERPA:

See FERPA – Office of the Registrar (https://registrar.illinois.edu/academic-records/ferpa/) for more information on the Family Educational Rights and Privacy Act (FERPA).

Any student who has suppressed their directory information pursuant to FERPA should self-identify to the instructor to ensure protection of the privacy of their attendance in this course.

Mental Health:

Significant stress, mood changes, excessive worry, substance/alcohol misuse or interferences in eating or sleep can have an impact on academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings which are covered through the Health Service Fee. If you or someone you know experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do for yourself and for those who care about you.

Counseling Center or (217) 333-3704

McKinley Health Center or (217) 333-2700

National Suicide Prevention Lifeline or (800) 273-8255

Rosecrance Crisis Line or (217) 359-4141 (available 24/7, 365 days a year)

If you are in immediate danger, call 911.

*This statement is approved by the University of Illinois Counseling Center

Sexual Misconduct Reporting Obligation:

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including supportive measures, resources, the campus disciplinary process, and law enforcement options.

Designated Confidential Employees: A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality.

Other information about resources and incident reporting.