Math 441: Differential Equations (3 credits)

Course Description

Math 441 is a basic course in ordinary differential equations. Topics include existence and uniqueness of solutions and the general theory of linear differential equations. Treatment is more rigorous than that given in MATH 285.

Credit is not given for both MATH 441 and any of MATH 284, MATH 285, and MATH 286.

For more details see http://catalog.illinois.edu/courses-of-instruction/math/

Prerequisite: MATH 241; MATH 347 or MATH 348 is recommended

Course Objectives

- Solve linear ODEs with constant coefficients
- Construct ordinary differential equation (ODE) models for physical systems
- Interpret direction fields to see possible solutions to ODEs
- Develop a working vocabulary for talking about differential equations
- Become familiar with various common techniques of solving differential equations
- Apply various theorems of existence and uniqueness of solutions do differential equations
- Classify ODEs in terms of order, linearity, and homogeneity
- Use Laplace transforms to solve differential equations
- Use eigenvalues and matrix techniques to work with ODEs

Course Content

• Method of Successive Approximations, Second Order Linear Equations, Principle of Superposition for Linear Homogeneous Equations, Second Order Linear IVPs, Theorem of Existence and Uniqueness for Second Order Linear IVPs

• Linear Independence, The Wronskian, Abel's Theorem, Second Order Linear Homogeneous IVP, Constant Coefficient Equations, Repeated Roots, Complex Conjugate Roots, Derivation of One of Euler's Formulas, Higher Order Linear Homogeneous Ordinary Differential Equations

• Constant Coefficient of nth Order Linear Homogeneous Equations, Operator Notation, nth Order Linear Homogeneous IVP, nth Order Linear Inhomogeneous IVP, Duplication Between complementary and particular solutions

• Mechanical Oscillators, Oscillator Equation, Free Undamped Oscillator, Free Damped Oscillator, Forced Undamped Oscillator, Beats, Resonance, Forced Damped Oscillator, Difference Between Particular Solutions, General Case: Forced Damped Oscillator, Practical Resonance

• Power Series Solutions, Absolute Convergence, Ratio Test, Comparison Test, Radius of Convergence, Operation with Series, Continuity and Differentiability

• Examples: Solutions Near an Ordinary Point, General Case for an Ordinary Point, Singular Points and the Euler Equation, Euler Equation Near x=0, Positive Discriminant (Two Real Distinct Roots), Zero Discriminant (Two Equal Roots), Negative Discriminant (Complex Conjugate Roots), Singular Point Not at x=0, Regular and Irregular Singular Points

• Solutions Near a Regular Singular Point, Series Solutions Near a Regular Singular Point

• Bessel's Equation of Order 0, Bessel Functions of Order 1, Bessel's Equation of Order \( \frac{1}{2} \), Bessel Functions of Order \( \frac{1}{2} \)

Format

- This is an online course featuring video lectures from the UIUC Summer 2018 course taught by Lecturer Aldo Manfroi.


- Students must be able to print out assignments, write out solutions, then scan their written work and upload it to Moodle to meet set deadlines.

- This course requires multiple paper-based exams that must be taken with an approved proctor. Exams may be taken on campus with NetMath proctoring; for off-campus options see https://netmath.illinois.edu/offcampus. Off-campus proctors must be able to scan completed exams and email them to NetMath for grading, as well as mailing the paper exam back for archival purposes.