# COURSE SYLLABUS

**Course Title:** **Computational Differential Equations**

Abbreviated Title As Appears on Transcript: `Comp Differential Equations`

Course Number: DMAT 321

Credit Hours: 3 credits [semester credit hours]

Course Description: A first course in the study of differential equations with emphasis on modern software computational techniques with geometrical and qualitative interpretations. Topics include first, second, and higher-order ordinary differential equations, analysis of forcing functions, Laplace Transforms, convolution integral techniques, Fast Fourier Transforms and data approximations, systems of differential equations, classical algebraic solution methods, power series solutions.

Prerequisite: Successful completion (C- or higher) of Calculus II or equivalent, or consent of instructor.

Course Workload: 3 semester credit hours • 3 student work hours per credit hour • 14 week Carnegie semester = 126 hours student course workload average

Examination Requirements: Proctored written final examination must be passed at 60% or higher to earn passing grade in course. "B" and "A" grade paths have additional examinations.
See https://www.distancecalculus.com/grades/ for more information.

Course Professor: Robert R. Curtis, Ph.D.<rcurtis@rwu.edu>, <robert@distancecalculus.com>

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Accredited by New England Commission of Higher Education (NECHE).
See https://www.rwu.edu/academics/accreditation/ for more information.

E-Textbook: *Differential Equations & Mathematica* by Davis/Porta/Uhl

Mathematical Software: Mathematica™ Computer Algebra & Graphing System

## ADA ACCOMMODATIONS

Roger Williams University has a continuing commitment to providing reasonable accommodations for students with documented disabilities. Students with disabilities who need accommodations in order to fully participate in this class are urged to contact Student Accessibility Services, as soon as possible, to explore the arrangements needed to be made to assure access. Student Accessibility Services is open Monday

through Friday from 8:00AM to 5:00PM Eastern Time; Email: sas@rwu.edu or Voice: 401-254-3841. For more information about SAS, visit https://www.rwu.edu/undergraduate/academics/student-academic-success/student-accessibility-services-sas

**Learning Outcomes for DMAT 321 - Computational Differential Equations**

1. To understand the core construction of the differential equation, and its classification parts
2. To understand the role of the forcing function in differential equations
3. To understand, observe, and compute the steady state solutions for a differential equation
4. To understand, observe, and compute solutions of differential equations with a variety of forcing functions, including DiracDelta, step, oscillatory, and others
5. To understand, observe, and compute solutions of differential equations with a variety of forcing functions, including DiracDelta impulses, step, oscillatory, et al.
6. To understand and compute solutions of second order differential equations oscillators and how forcing functions affect their solutions
7. To understand and compute manual solutions of first and second order differential equations using classical techiques
8. To understand and compute with the Laplace Transform method
9. To understand and compute graphical and numerical solution methods of differential equations
10. To understand and compute solutions of linear systems of differential equations
11. To understand and compute polynomial approximations to solutions of differential equations

Syllabus Topics Outline for DMAT 321 - Computational Differential Equations

1. Getting Started
   - 1.1. Email and Chat
   - 1.2. Learning About the Course
   - 1.3. Required Hardware
   - 1.4. Software Fundamentals

2. Exponential Differential Equations
   - 2.1. Unforced DEs
   - 2.2. Forced DEs
   - 2.3. Steady State
   - 2.4. Personal Finance
   - 2.5. Step Function and Dirac Delta Function
   - 2.6. Tangent Vectors
   - 2.7. Initial Conditions
   - 2.8. Integration Factors

3. Second-Order Differential Equations
   - 3.1. Overdamped and Underdamped Oscillators
   - 3.2. Linear Forced and Unforced Oscillators
   - 3.3. Homogeneous and Inhomogeneous Equations
   - 3.4. Convolution Method

- 3.5. Characteristic Equations
- 3.6. Euler's Formula
- 3.7 Impulse Forcing
- 3.8 Dirac Delta Convolutions
- 3.9 Springs and Electrical Charges
- 3.10 Higher Order Equations

4. Laplace Transforms
   - 4.1 Laplace Transforms of First and Second Order Equations
   - 4.2 Fourier Analysis and Fourier Fit Approximations

5. Graphical Analysis of Differential Equations
   - 5.1 Euler's Method
   - 5.2 Flow Plots and Trajectories
   - 5.3 Preditor-Prey Model
   - 5.4 Logistic Harvesting

6. First-Order Differential Equations
   - 6.1 Autonomous Equations
   - 6.2 Non-Autonomous Equations
   - 6.3 Separation of Variables Solving Method

7. Systems of Differential Equations
   - 7.1 Flows and Trajectories
   - 7.2 Conversion Between Higher Order ODEs and Systems
   - 7.3 Relationship to Eigenvalues and Eigenvectors

8. Power Series Solutions of Differential Equations
   - 8.1 Recursion Relations
   - 8.2 Comparing Series Solution to Numerical Solution
   - 8.3 Barriers