COURSE SYLLABUS

Course Title: **Honors STEM Calculus II**

Abbreviated Title As Appears on Transcript: `Honors STEM Calculus II`

Course Number: DMAT 264

Credit Hours: 5 credits [semester credit hours]

Course Description: An honors-level second course in the differential and integral calculus for engineering and science with emphasis on computational techniques, graphical analysis, and algebraic methods. Topics include integration theory, algebraic methods of integration, integral functions and transformations, improper and numerical integrals, applications of integration to geometry and physics, double integrals, integration over regions with parametric boundary, splines, barriers, Taylor's Theorem, L'Hopital's Rule, infinite sequences and series. Honors courses will include greater breadth and depth of topics, and develop technical writing skills, culminating in a mathematical term paper on an approved topic.

Prerequisite: Successful completion with B grade or higher in Calculus I or equivalent, or consent of instructor.

Course Workload: 5 semester credit hours • 3 student work hours per credit hour • 14 week Carnegie semester = 210 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>

University Information: Roger Williams University, University College, 1 Empire Plaza, Providence, RI, USA 02903. Roger Williams University, 1 Old Ferry Road, Bristol, RI 02809. Accredited by New England Commission of Higher Education (NECHE).
See https://www.rwu.edu/academics/accreditation/ for more information.

E-Textbook: *Calculus & LiveMath* by Robert R. Curtis, Ph.D., adapted from Davis/Porta/Uhl *Calculus&Mathematica* courseware series

Mathematical Software: LiveMath™ 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 264 - Honors STEM Calculus II

1. To understand and compute algebraic integrals using a variety of symbolic techniques, including substitution, integration by parts, integration via differentiation, iteration methods
2. To understand and compute with the Fundamental Theorem of Calculus
3. To understand and compute solutions to applications problems involving integrals
4. To compute measurements of volumes of geometric objects using integrals (slides, surfaces of rotation
5. To understand and compute with Green's Theorem
6. To understand and compute parametric and Polar function integrals
7. To understand and compute double integrals
8. To understand and compute splines and polynomial approximations
9. To understand and compute with Taylor's Theorem
10. To understand and compute with L'Hopital's Rule and using expansions to compute limits
11. To understand and compute sequences and series
12. To understand and compute convergence or divergence of sequences and series using various tests (Ratio, Integral, p-Test)
13. To understand and compute 3D vector analysis, dot product, planes, and cross products
14. To understand and compute partial derivatives and tangent planes to a surface

Honors Topics:

15. *To understand the concept of integration in finite terms and its connection to integration techniques
16. *To understand and compute basic solutions of differential equations in relation to integration techniques.
17. *To understand and compute polynomial approximations to solutions of differential equations.
18. *To understand and compute near-finite-term integrals and their expression in power series.
19. *To understand and compute integrals using complex integration techniques
20. *To understand and compute numerical integration techniques of Newton, Midpoint, and Runge-Kutta, and higher RK approximations.
21. *To understand and explore higher integral functions, such as those defined by elliptical and hyperbolic integrals
22. *To explore initial topics in Analytical Number Theory
23. *To understand higher special functions defined by either series or integral formulations
24. *To understand and compute more advanced polynomial and rational polynomial approximation techniques (Chebyshev, et al)
24. *To develop mathematical technical writing skills, culminating in a term paper on an approved topic

Syllabus Topics Outline for DMAT 264 - Honors STEM Calculus II

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

2. Integration
   - 2.1 Measuring Area Under a Curve
   - 2.2 Definition of the Integral
   - 2.3 Properties of Integrals, Symmetry
   - 2.4 Integrals of Data Functions
   - 2.5 Numerical Methods: Rectangles, Trapezoids
   - 2.6 Undefined Integrals
   - 2.7 Numerical Calculation of Integrals

3. Fundamental Theorem of Calculus
   - 3.1 Derivative of an Integral
   - 3.2 Integral of a Derivative
   - 3.3 Fundamental Formula
   - 3.4 Distance, Velocity, and Acceleration
   - 3.5 Improper Integrals
   - 3.6 More Properties of Integrals
   - 3.7 Applications: Measure Accumulation Totals
   - 3.8 Indefinite Integrals and Antiderivatives

4. Measurements via Slicing
   - 4.1 Measuring Area via Slicing
   - 4.2 Measuring Volume via Slicing
   - 4.3 Density and Mass
   - 4.4 Accumulation of Rates
   - 4.5 Arc Length

5. Computing Integrals
   - 5.1 Algebraic Antiderivatives
   - 5.2 Integrals of Standard Functions: Polynomial, Exponential, Trigonometric, Logarithmic
   - 5.3 Transforming Integrals: u-substitution
   - 5.4 Measuring Area under Parametric Curves
   - 5.5 Integrals of Polar Functions

6. Measurements via Slicing
   - 6.1 Measuring Area via Slicing
   - 6.2 Measuring Volume via Slicing
   - 6.3 Density and Mass

6.4 Accumulation and Rates
6.5 Arc Length

7. Double Integrals
   7.1 Measuring Area and Volume
   7.2 Gauss-Green Formula
   7.3 Changing Order of Iterated Integrals

8. Integration Techniques
   8.1 Separable Differential Equations
   8.2 Integration By Parts
   8.3 Integration Patterns and Reduction Formulas
   8.4 Partial Fractions Technique
   8.5 Trigonometric Integrals
   8.6 Trigonometric Substitution
   8.7* Integration via Differentiation Technique
   8.8* DeMoivre's Theorem
   8.9* Complex Integration

9. Taylor's Expansion of a Function
   9.1 Splines and Smooth Splines
   9.2 Points of Contact
   9.3 Application: Road Curves
   9.4 Taylor Expansion
   9.5 Recognizing Familiar Expansions
   9.6 Using Expansions for Approximations
   9.7 Derivatives and Integrals of Expansions
   9.8 Expansions At Other Points
   9.9 Newton's Method
   9.10 Calculating Limits: L'Hopital's Rule
   9.11* Expansions and Solving Differential Equations
   9.12* Complex Exponentials
   9.13* Euler, Midpoint, Runge-Kutta Integral Estimates

10. Sequences and Series
   10.1 Sequences of Numbers
   10.2 Series of Numbers
   10.3 Convergence
   10.4 Convergence of Taylor Expansions
   10.5 Barriers: Radius of Convergence
   10.6. Shared Convergence Intervals for Derivatives and Integrals of Functions
   10.7 Applications: Drug Dosing

11. Power Series
   11.1 Basic Definition

- 11.2 Solutions of Differential Equations
- 11.3 Convergence Intervals of Power Series
- 11.4 Ratio Test and Other Convergence Tests
- 11.5 Finding Series Convergence Values via Power and Taylor Series
- 11.6* Famous Number Theory Infinite Series Values
- 11.7* Near-Finite Term Integration Formulas via Power Series

12.* Differential Equations
- 12.1* Types of Differential Equations
- 12.2* Linkage to Algebraic and Numerical Integration Theory
- 12.3* Power Series Solutions to Differential Equations
- 12.4* Elliptical and Hyperbolic Integration Functions

13. Polar Coordinates
- 13.1 Basic Graphing
- 13.2 Recognizable Curves
- 13.3 Differentiation and Integration in Polar Coordinates

14. Vector Analysis
- 14.1 Vector Arithmetic
- 14.2 Dot Product, Cross Product
- 14.3 Planes
- 14.4 Partial Derivatives
- 15.5 Tangent Planes

15.* Algebraic Integration Theory
- 15.1* Machine Integration Engines
- 15.2* Integration in Finite Terms
- 15.3* Integratability and Limitations
- 15.4* Defining advanced special functions using integrals or series

16.* Special Functions and Approximations
- 16.1* Approximating Functions with Polynomials and Rational Polynomials
- 16.2* Defining advanced special functions using integrals or series
- 16.3* Elliptical Curves and Fermat's Last Theorem
- 16.4* Exploring Special Named Functions