COURSE SYLLABUS

Course Title: **Multivariable Calculus and Vector Analysis**

Abbreviated Title As Appears on Transcript: `Multivariable Calculus IV`

Course Number: DMAT 355

Credit Hours: 4 credits [semester credit hours]

Course Description: A first course in multivariable differential and integral calculus, with emphasis on computational techniques, vector field analysis, and the generalized Fundamental Theorem of Calculus giving insight to the classical theorems of Green, Gauss, and Stokes. Topics include geometric analysis of multivariable functions, partial derivatives, level curves and surfaces, optimization, properties of vector fields, gradients, potential functions, path integrals and independence, field singularities, divergence and rotation, multiple integration, integral coordinate Jacobian transforms.

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

Course Workload: 4 semester credit hours • 3 student work hours per credit hour • 14 week Carnegie semester = 168 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: *Vector Calculus & LiveMath* by Robert R. Curtis, Ph.D., adapted from Davis/Porta/Uhl *Vector 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 355 - Multivariable Calculus and Vector Analysis

1. To understand the core geometrical elements of Euclidean space
2. To understand and compute vector operations and their geometrical interpretations
3. To understand and compute partial derivatives and gradient functions
4. To understand and compute curves, level curves, surfaces, and level surfaces to multidimensional functions
5. To understand and compute vector-valued functions and their geometric representations
6. To understand and compute the classical optimization procedure of Lagrange Multipliers
7. To understand, compute, and graph vector fields and their associated metrics
7. To understand and compute path integrals of vector fields
8. To understand, compute, and graph sources, sinks, and singularities of vector fields
9. To understand and compute the divergence of a vector field, and its associated computations
10. To understand and compute the rotation and curl of a vector field, and its associated computations.
11. To understand and compute path integrals in the presence of singularities
12. To understand and compute multiple integrals, and their associated geometrical interpretations
13. To understand and utilize Fubini's Theorem for reordering integrations
14. To understand and compute Jacobian transformations of multiple integrals
15. To understand and compute cylindrical, spherical, and other coordinate systems, and their associated measurments with derivatives and integrals
16. To understand an introduction to the Generalized Fundamental Theorem of Calculus, and its variations in the Divergence Theorem, and the Theorems of Gauss, Green, and Stokes.

Syllabus Topics Outline for DMAT 355 - Multivariable Calculus and Vector Analysis

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

2. Vectors
   - 2.1 Geometry of Vectors
   - 2.2 Tangent Vectors; Velocity Vectors, Acceleration Vectors
   - 2.3 Vector Length
   - 2.4 Dot Products
   - 2.5 Vector Projection
   - 2.6 Perpendicularity
   - 2.7 Lines
   - 2.8 Normal Vectors

- 2.9 Cross Product
- 2.10 Planes in 3D
- 2.11 Normal, Binormals, Curvature, Torque

3. The Derivative
   - 3.1 Partial Derivatives
   - 3.2 Gradient
   - 3.3 Level Curves and Surfaces
   - 3.4 Linearization
   - 3.5 Total Differential
   - 3.6 Lagrange Multipliers

4. Vector Fields
   - 4.1 Plotting and Trajectories
   - 4.2 Flow-Along and Flow-Across Curves
   - 4.3 Differential Equations and Vector Fields
   - 4.4 Path Integrals
   - 4.5 Gradient Fields
   - 4.6 Sources, Sinks
   - 4.7 Divergence Theorem
   - 4.8 Singularities
   - 4.9 Rotation and Curl
   - 4.10 Introduction to Potential Functions

5. Multiple Integrals
   - 5.1 Basic Computation
   - 5.2 u-v Transformations; Jacobians
   - 5.3 Measurement of Volume, Mass, Density
   - 5.4 3D Integrals
   - 5.5 Average Value
   - 5.6 Fubini's Theorem

6. Other Coordinate Systems
   - 6.1 Cylindrical Coordinates
   - 6.2 Spherical Coordinates
   - 6.3 Integration in Other Coordinate Systems

7. Gauss, Green, Stokes Theorems
   - 7.1 Green's Theorem
   - 7.2 Stokes' Theorem
   - 7.3 Divergence Theorem
   - 7.4 Generalized Fundamental Theorem of Calculus
   - 7.5 Sources, Sinks, and 3D Gauss's Formula
   - 7.6 Surface Integrals