DISTANCE CALCULUS @ RWU ROGER WILLIAMS UNIVERSITY

COURSE SYLLABUS

Course Title: **Computational Differential Geometry**

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

Course Number: DMAT 451

Credit Hours: 4 credits [semester credit hours]

Course Description: A first course in differential geometry from a computational and graphical standpoint. Topics include a comprehensive study of curves and surfaces with emphasis on exploring a catalog of named geometrical objects, curvature and other metrics, orientable, non-orientable, ruled, and minimal surface, culminating with an introduction to the Gauss-Bonnet Theorem.

Prerequisite: Successful completion (C- or higher) of Multivariable Calculus 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 and oral final examination must be passed at 70% or higher to earn passing grade in course. "B" and "A" grade paths have additional examinations and assignments. See https://www.distancecalculus.com/grades/ for more information.

Course Professor: Robert R. Curtis, Ph.D.<rcurtis@rwu.edu>, <robert@distancecalculus.com>
Roger Williams University, Extension School, 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:

Differential Geometry of Curves and Surfaces using Mathematica, 3rd Edition, by Gray et al.

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

COURSE RULES

Academic Honesty

Academic Dishonesty in a Distance course includes copying or relying upon another person's work. Working with other students is good and encouraged, but the work you submit for this course must be genuinely your own work. Private tutors are allowed, but you must notify the instructor that you have obtained a private tutor to aid in your studies. Any documented instance of Academic Dishonesty will be grounds for immediate failure in this course.

Final (and Other) Examinations

A written and oral proctored final exam will occur at the student's location over video with the course professor; The student must score 70% or higher on this final exam to be eligible to earn a passing grade in the course.

Communication

Communication is the key to success in a Distance course. It is the student's responsibility to keep good communication channels with the instructors during the course; failure to participate in the course does not constitute "dropping" the course (Withdrawal from the course must be requested in writing to the instructors before the completion date deadline)

Roger Williams University Policies & Procedures

Roger Williams University has Policies & Procedures that all students must follow, including the Roger Williams University Student Handbook. Student must agree to follow all stated rules governing student conduct listed on the Roger Williams University website, and at the Roger Williams University Course Catalog

Course Completion 1 Year Rule

All Distance Calculus students are afforded 1 Year to finish their course from the Date of Enrollment. Students will be placed in the Academic Semester based upon their Date of Enrollment for academic records purposes. If a student does not finish the course, and does not request a Course Withdrawal for a W, then an "F" grade will be issued.

No Chatbots / AI

Students must pledge to **not** use any Chatbot/AI at all - **period**. Student must pledge to **limit** use of search engines (Google, Bing, etc) to a minimal level. Student must pledge to not engage in dishonest disguise of any Chatbot/AI/Search Engine source of information as student's own honest academic work. Verified chatbot usage will result in an "F" course grade, and will be referred to the Roger Williams University Academic Integrity Committee.

Learning Outcomes for DMAT 451 - Computational Differential Geometry

1. To use computer graphing tools to visualize 2D and 3D curves and surfaces
2. To understand and compute various metrics about parametric and non-parametric curves and surfaces
3. To understand and compute the key concept of curvature, and understand its relationship to derivatives and differential equations
4. To understand the role of motions in geometry
5. To understand and compute the Frenet frames for curves
6. To understand and compute the concept of the derivative for vector fields
7. To understand and compute the local Gauss map for surfaces
8. To understand and compute the concept of orientability of surfaces
9. To understand and compute Gaussian and Mean curvature
10. To understand and compute Ruled and Minimal Surfaces
11. To be introduced to the Gauss-Bonnet theorem

Syllabus Topics Outline for DMAT 451 - Computational Differential Geometry

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

2. Curves
   - 2.1 Euclidean Spaces
   - 2.2 2D and 3D Parametric Curves
   - 2.3 Arclength
   - 2.4 Curvature vs. Derivative
   - 2.5 Angles
   - 2.6 Catalog of Famous Curves

3. Alternative Ways of Plotting Curves
   - 3.1 Implicit Curves
   - 3.2 Contour Plots
   - 3.3 Polar Coordinates
   - 3.4 New Curves from Old

4. Solving Curvature Equations
   - 4.1 Euclidean Motions
   - 4.2 Intrinsic Equations
   - 4.3 Assigned Curvature

5. Global Properties of Plane Curves
   - 5.1 Total Signed Curvature
   - 5.2 Turning Numbers

- 5.3 Rotation Index
- 5.4 Convexity
- 5.5 Constant Width
- 5.6 Support Functions

6. Space Curves
   - 6.1 Tangent, Normal, Binormal Frames
   - 6.2 Curvature and Torsion
   - 6.3 Frenet Formulas
   - 6.4 Arbitrary Speed Curves
   - 6.5 Tubes and Tori

7. Fundamental Theorem of Space Curves
   - 7.1 Assigned Curvature and Torsion
   - 7.2 Contact
   - 7.3 Curves That Lie on a Sphere
   - 7.4 Curves of Constant Slope

8. Calculus of Euclidean Space
   - 8.1 Tangent Vectors and Directional Derivatives
   - 8.2 Tangential Maps
   - 8.3 Vector Fields
   - 8.4 Derivatives of Vector Fields

9. Surfaces in Euclidean Space
   - 9.1 Patches
   - 9.2 Local Gauss Map
   - 9.3 Regular Surfaces
   - 9.4 Level Surfaces
   - 9.5 Catalog of Famous Surfaces

10. Non-Orientable Surfaces
    - 10.1 Orientability
    - 10.2 Mobius Strip and Klein Bottle
    - 10.3 Projective Planes

11. Surface Metrics
    - 11.1 Distance
    - 11.2 Isometries
    - 11.3 Conformal Maps
    - 11.4 Gaussian and Mean Curvature
    - 11.5 Non-Parametrically-Defined Surfaces

12. Ruled and Other Surfaces
    - 12.1 Examples

12.2 Curvature
12.3 Surfaces of Revolution
12.4 Examples of Minimal Surfaces