ROWAN UNIVERSITY
Department of Mathematics

Syllabus

Math 01.507 - Differential Geometry

CATALOG DESCRIPTION:

Math 01.507 Differential Geometry, 3 s.h.
Prerequisites: Math 01.210 (Linear Algebra) and Math 01.230 (Calculus III), or permission of instructor

This course explores the application of calculus towards the study of higher-dimensional surfaces and their geometry. Topics include geodesics, tangent space, directional derivative, Riemannian metrics, isometries, Gaussian curvature, first and second fundamental forms, Gauss-Bonnet Theorem, minimal surfaces, differential manifolds, connections, and Riemannian curvature tensors. Special topics (at the discretion of the instructor) may include Lie groups, symmetric spaces, general relativity, cohomology, and complex geometry. Students will be required to use a computer algebra system to gain geometric intuition.

OBJECTIVES:

Students in this course will learn how the concepts of calculus can be applied to understand the geometry of mathematical surfaces such as planes, spheres, hyperbolic spaces and manifolds in general. Topics include geodesics, tangent space, directional derivative, Riemannian metrics, isometries, Gaussian curvature, first and second fundamental forms, Gauss-Bonnet Theorem, minimal surfaces, differential manifolds, connections, and Riemannian curvature tensor. Special topics (at the discretion of the instructor) may include Lie groups, symmetric spaces, general relativity, cohomology, and complex geometry. Students will be required to use a computer algebra system to solve problems and gain geometric intuition.

CONTENT:

1. **Surfaces and Straightness**
    1. Geodesic
    2. Surfaces of revolution
    3. Geodesics on the Sphere
    4. Geodesics on the Hyperbolic Plane
    5. Geodesics on the Hyperbolic Disk

2. **Surfaces and Curvature**
    1. Tangent space
    2. Extrinsic Curvature
    3. Intrinsic (Geodesic)Curvature
    4. Directional Derivative
    5. Riemannian Metrics
    6. Isometries
    7. Stereographic Projection

3. **Surfaces and Area**
    1. Parallel Transport
    2. Holonomy
    3. Gaussian Curvature
    4. First and Second Fundamental Form
    5. Gauss-Bonnet Theorem
    6. Mean Curvature and Minimal Surfaces
    7. Surfaces of Constant Curvature

4. **Manifolds and Curvature**
    1. Atlas and Local Coordinates
    2. Differentiable Manifolds
    3. Covariant Derivative and Connections
    4. Christoffel Symbols
    5. Lie Brackets and Vector Fields
    6. Riemannian Curvature Tensors

5. **Special Topics (at the discretion of the instructor)**
    1. Lie Groups and Symmetric Spaces
    2. Lorentz Metrics and General Relativity
    3. Differential Forms and Cohomology
    4. Complex Geometry
    5. Foliations

TEXTS:

Henderson, David W., Differential Geometry: A Geometric Introduction, Prentice-Hall, 1998.

Boothby, William M., An Introduction to Differential Manifolds and Riemannian Geometry, Academic Press, 1986.

Reviewed: 04/2021