

Course Title: Differential Geometry

Course Code: MATH-402

Course Type: Major Math

Prerequisites: Tensor Analysis

Credit Hours: 3 (3 + 0)

Course Objectives: By the end of this course, students will be able to:

- Understand concepts about curves, surfaces, and their properties.
- Perform calculations involving the curvature and torsion of curves.
- Understand and compute different forms of surfaces.
- Analyze and solve problems related to geodesics and curvature of surfaces.
- Read and write rigorous mathematical proofs in the context of geometry.
- Build a solid foundation for further study in advanced mathematics, including courses on Riemannian geometry, topology, and manifold theory.

Course Contents:

Theory of Curves: Introduction to Differential Geometry, index notation and summation convention, plane curves and signed curvature, Space curves, arc length, tangent, normal and binormal, Osculating, normal and rectifying planes, Curvature and torsion, The Frenet-Serret theorem, Natural equation of a curve, Involutes and evolutes, helices, circles and cycloids, Fundamental existence theorem of space curves.

Geometry of Surfaces: Coordinate transformation, examples of surfaces, quadric surfaces, Tangent plane and surface normal, The first fundamental form and the metric tensor, Metric properties of surfaces, Computation of lengths, areas, and angles, Christoffel symbols of first and second kinds, The second fundamental form, Principal, Gaussian, mean, geodesic and normal curvatures, Gauss's Theorem Egregium, Gauss and Weingarten equations, Gauss and Codazzi equations.

Recommended Books:

1. Abbena, E., Salamon, S., & Gray, A., *Modern differential geometry of curves and surfaces with Mathematica*, Chapman and Hall/CRC, 2017.
 2. Banchoff, T. F., & Lovett, S., *Differential geometry of curves and surfaces*, Chapman and Hall/CRC, 2022.
 3. Lipschutz, M. M., *Schaum's outline of differential geometry*, McGraw Hill Book Company, 1969.
 4. Pressley, A. N., *Elementary differential geometry*, Springer, 2010.
 5. Toponogov, V. A., *Differential geometry of curves and surfaces*, Springer, 2005.
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