MATH-803 Geometry

Credit Hours: 3-0

Prerequisite: None

Objectives and Goals: After having completed this course, the students would be expected to understand classical concepts in the local theory of curves, surfaces and manifolds. Also the students will be familiar with the geometrical interpretation of the terminology used in the course.

Detailed Course Contents: Curves, Surfaces -Topological Invariants, Geometry on a Surface or Riemannian Geometry, Geodesics, Generalization of the Concept of Tangent and of Tangent Plane, to a Surface Manifolds -Tensor Fields - Covariant Differentiation, Tangent Vectors and Mappings, Tangent or Contravariant" Vectors, Vectors as Differential Operators, The Tangent Space to Mn at a Point, Change of Coordinates, Vector Fields and Flows on Rn, Vector Fields on Manifolds, Functionals and the Dual Space, The Differential of a Function, Scalar Products in Linear Algebra, Riemannian Manifolds and the Gradient Vector, The Tangent Bundle, The Cotangent Bundle and Phase Space, Covariant Tensors, Contravariant Tensors, Mixed Tensor, Properties, The Tensor Product of Covariant Tensors, Wedge Product, The Geometric Meaning, Special Cases, Computations and Vector Analysis, The Exterior Differential, A Coordinate Expression for d, The Pull-Back of a Covariant Tensor,. Integration of a p-Form in Rp, Integration with boundaries, Stokes' theorem, The Lie Bracket,The Lie Derivatives of Forms, Covariant Derivative, Curvature of an Affine Connection, Geodesics.

Course Outcomes: Students are expected to understand classical concepts in the local theory of curves, surfaces and manifolds. Also, the students will be familiar with the geometrical interpretation of the terminology used in the course. Students will be able to apply learned concepts in other related fields.

Text Books:

T. Frankel, The Geometry of Physics, Cambridge University Press, 2012 (TB2).

A. Visconti, Introductory Differential Geometry for Physicists,
World Scientific, 1992(TB1).

Reference Books:

1. Bernard F. Schutz , Geometrical Methods of Mathematical Physics, Cambridge University Press, 1980.
2. Serge Lang, Fundamentals of Differential Geometry, Springer, 1999.

ASSESSMENT SYSTEM

Nature of assessment	Frequency	Weightage (%age)
Quizzes	Minimum 3	10-15
Assignments	-	5-10
Midterm	1	25-35
End Semester Examination	1	40-50
Project(s)	-	10-20

Weekly Breakdown		
Week	***Section***	***Topics***
1	1(TB2)	Curves, handouts
2	2(TB2)	Surfaces -Topological Invariants,
3	3(TB2)	Geometry on a Surface or Riemannian Geometry
4	4(TB2)	Geodesics
5	5(TB2)	Generalization of the Concept of Tangent and of Tangent Plane to a Surface
6	(TB1,TB2) 1.1a,1.2(a-c) 1.3(a-c)	Manifolds -Tensor Fields - Covariant Differentiation Tangent Vectors and Mappings, Tangent or “Contravariant” Vectors, Vectors as Differential Operators, The Tangent Space to Mn at a Point
7	(TB1)1.4(a-b)	Change of Coordinates, Vector Fields and Flows on Rn, Vector Fields on Manifolds

8	(TB1)2.1(a-d)	Functionals and the Dual Space, The Differential of a Function, Scalar Products in Linear Algebra, Riemannian Manifolds and the Gradient Vector
9	**Mid Semester Exam**	
10	(TB1)2.2a, 2.3(a-b)	The Tangent Bundle, The Cotangent Bundle and Phase Space
11	(TB1)2.4(a-e).	Covariant Tensors, Contravariant Tensors, Mixed Tensor, Properties
12	(TB1)2.5(a-e)2.6(a-c)	The Exterior Differential, A Coordinate Expression for d,
13	(TB1)2.7a,	The Pull-Back of a Covariant Tensor,
14	3.1, 3.2, 3.3	Integration of a p-Form in Rp, Integration with boundaries, Stokes' theorem
15	(TB1)4.1, 4.2a.	The Lie Bracket, The Lie Derivatives of Forms
16	(TB1)9.1(a-c)	Covariant Derivative, Curvature of an Affine Connection Godesics
17		Review
18	**End Semester Exam**	