Applications of Differential Geometry to Physics

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This is a course designed to develop the Differential Geometry required to follow modern developments in Theoretical Physics. The following topics will be discussed.

- Geometry of Lie Groups
  1. Manifolds
  2. Vector fields and one–parameter groups of transformations
  3. Group action on manifolds
  4. Metrics on Lie Groups and Kaluza Klein theories.
- Classical mechanics
  1. Symplectic and Poisson structures
  2. Geodesic flow, Killing vectors, Killing Tensors.
  3. Null Kaluza–Klein reductions
  4. Integrable Systems
- Fibre bundles and instantons
  1. Principal bundles and vector bundles.
  2. Connection and Curvature
  3. Instantons

Basic General Relativity (Part II level) or some introductory Differential Geometry course (e.g. Part II differential geometry) is essential. Part III General Relativity is desirable.

References

[1] Arnold. V. Mathematical Methods of Classical Mechanics. Springer.

[2] Dunajski, M. Solitons, Instantons, and Twistors, *Oxford Graduate Texts in Mathematics*, Oxford University Press, 2009.

[3] Eguchi, T., Gilkey, P. and Hanson. A. J. Physics Reports 66 (1980) 213-393