

School of Mathematics

Course 447 — Differential Geometry and Topology
(JS & SS Mathematics, SS Theoretical Physics)

2005-06

Lecturer: Dr. C. Lazaroiu

Requirements/prerequisites: A good understanding of certain results in multivariate analysis. (211, 221)

Duration: 21 weeks

Number of lectures per week: 3 including tutorials

Assessment:

End-of-year Examination: One 3-hour exam in May/June.

Description:

The course is an introduction to differential geometry and topology at the advanced undergraduate/beginning graduate level.

The course is recommended to mathematicians and to those theoretical physicists interested in gravitational physics and gauge theories.

The course is concerned with mathematical results, and not with physical applications.

The following topics will be covered:

- Basic differential geometry (manifolds, differential structures, differentiable maps, vector and tensor fields, differential forms, Cartan calculus, Lie group actions, orientability, integration on manifolds, de Rham cohomology)
- Basic Riemannian geometry (metrics, Levi-Civita connection, curvature tensor, basic Hodge theory)
- Fiber bundles (principal and vector bundles, connections, characteristic classes, Chern-Weyl theory)
- Elements of algebraic topology (homology and cohomology theories, applications to singular, Chech and de Rham theories). Warning: The course assumes a certain amount of mathematical maturity, in particular a thorough understanding of analysis, multilinear algebra, group theory, general topology and basic category theory.

See <http://www.maths.tcd.ie/~calin/teaching/447.html> for further detail.

Textbooks:

Core textbook: Shigeyuki Morita, Geometry of Differential Forms, American Mathematical Society (2001) ISBN: 0821810456

Recommended: The treatment of some topics is inspired by the following books:

1. Raoul Bott, Loring W. Tu, Differential Forms in Algebraic Topology, Springer (1995) ISBN: 0387906134

2. Norman Steenrod, The Topology of Fibre Bundles, Princeton University Press (1999) ISBN: 0691005486
3. John Milnor, James D. Stasheff, Characteristic Classes, Princeton University Press (1974) ISBN: 0691081220

Other classic references:

- Shoshichi Kobayashi, Katsumi Nomizu, Foundations of Differential Geometry, vols 1,2; Wiley-Interscience; New edition (1996) ISBN: 0471157333
- Michael Spivak, A comprehensive introduction to differential geometry vols 1-5, Publish or Perish, Inc; 3rd edition (1999) ISBN 0914098705
- Dale Husemoller, Fibre Bundles, Springer; 3rd edition (1993) ISBN: 0387940871

Special topics:

- John Milnor, Topology from the Differentiable Viewpoint, Princeton University Press; Revised edition (1997) ISBN: 0691048339
- Glen E. Bredon, Topology and Geometry, Springer (1997) ISBN: 0387979263
- J. P. May A Concise Course in Algebraic Topology, University Of Chicago Press (1999) ISBN: 0226511839

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