Plan for lectures DG-2017

Boris Kruglikov

U34: Section 1. Submanifolds in Euclidean spaces. First and Second quadratic forms and curvatures.
Book Sternberg: Section 1.1-1.5. Book Kuhnel 4C, 4E.
Important: Volume formula, Gauss and Weingarten maps, Gauss theorem egregium.

U35: Abstract manifolds. Algebra of smooth functions, maximal ideals, quotients.
Notes: DG-I, Lectures 1-4. Book Kuhnel 5A.
Important: Examples of manifolds, maximal ideals, jets.

U36: Tangent and Cotangent spaces. Vector bundles, sections, fields.
Notes: DG-I, Lectures 6-8. Book Kuhnel 5B.
Important: All basic knowledge.

U37: Tensors on vector spaces and manifolds. Differential forms.
DG-II, Lectures 10-11, 13-14; DG-III, Lectures 20-26. Book Kuhnel 6A. Book Sternberg S3.8.
Important: All basic knowledge. Be able to compute exterior products, substitution (hook).

U38: Section 2. Rules of calculus. Lie derivative.
Book Sternberg S2.1-2.13. Notes: DG-II, Lectures 12, 15, 17-18. DG-IV. Lectures 27-30.
Important: De Rham differential and its properties. Lie and inner derivatives and their properties, commutation relations. The Cartan and Weyl formulae.

U39: Section 3. Linear connections. Torsion and curvature.
Book Sternberg: Section 3. Book Kuhnel 4A-4B.
Important: Be able to demonstrate that torsion and curvature are tensors. Be able to compute those (in Maple). Symmetric and flat connections.

U40: Section 4 Levi-Civita connection. Riemannian geometry and curvature tensor.
Book Sternberg: Section 4 (4.1-4.6, 4.8-4.9). Book Kuhnel 5C-5D.
Important: Know the formulae (both coordinate and coordinate-free) for the Levi-Civita connection. Know all the symmetry properties of the Riemann tensor.

U41: Reading: Book Sternberg: S4.7
Assignment I (Fronter)

U42: Section 5. Lie groups and Lie algebras.
Book Sternberg: Section 5. Notes: DG-I, Lecture 9. Our current lectures!
Important: Definitions, examples, bi-invariant metric, computations (in Maple).

U43: Cartan's structure equations and applications to relativity (partially Section 6).
Selection from Book Sternberg: Section 6. Discussion Sections 7-10.

U44: Section 12: Hodge star operator. Duality and electromagnetism.
Book Sternberg: Section 12.
Important: Know the definition and properties, incl. the square of the Hodge star. Know the form of the Maxwell equations via differential and codifferentail.

U45: Mathematical general relativity.
Book Sternberg: S4.10-4.13. Discussion of Section 13. Book Kuhnel 6B-6C.
Important: Know components of the Riemann tensor. Formulate Einstein field equations. Be able to check when a metric satisfies those (in Maple).

U46: Reading: Book Sternberg: Section 11, 14.
Assignment II (Fronter)

U47: Preparation to exam

U48: Summary and outlook.
Meeting Monday 27/11 at the usual time 14:00.

U49: **Exam 4/12**