UNIVERSITY OF CRETE
DEPARTMENT OF MATHEMATICS AND APPLIED MATHEMATICS

SPRING 2026 SEMINAR

Differential Geometry on principal fibre bundles and Gauge Theory

I. Differential Geometry on principal fibre bundles

1. Principal fibre bundles
2. Associated vector bundles
3. Connections on principal fibre bundles
4. Automorphisms
5. Automorphisms and connections
6. Curvature
7. Local gauge fields and field strength
8. Parallel transport
9. Linear connections on associated vector bundles
10. Explicit formula for parallel transport
11. Ad-valued differential forms and the Bianchi identity
12. The absolute differential of a connection
13. Reduction of principal fibre bundles
14. Principal fibre bundles and characteristic classes

II. Yang-Mills Theory

1. Maxwell's equations as Yang-Mills equations
2. The Hodge-star operator on pseudo-Riemannian manifolds
3. The Yang-Mills functional and equation
4. Self-dual connections (instantons)
5. Source free electromagnetism
6. The Yang-Mills-Higgs functional
7. Scalar electrodynamics formalism

Bibiography

1. K. Athanassopoulos, An introduction to smooth manifolds: de Rham cohomology and characteristic classes, Course Notes in electronic form in the website http://users.math.uoc.gr/ athanako/diff-manifolds-v2.pdf

2. H. Baum, Eichfeldtheorie: Eine Einfürung in die Differentialgeometrie auf Faserbündeln, Springer, 2009

3. M.J.D. Hamilton, Mathematical Gauge Theory with applications to the standard model of particle Physics, Springer, 2017

4. S. Kobayashi and K. Nomizu, Foundations of Differential Geometry, Vol. I, Interscience Publishers, 1963

The seminar lectures will be held every Tuesday at 11:00 in room B 214.