

School of Mathematics**MA3429 — Differential Geometry**

2011-12

(SS Theoretical Physics
JS & SS Mathematics)

Lecturer: Prof. P. Taylor**Requirements/prerequisites:****Duration:** Michaelmas Term, 11 weeks**Number of lectures per week:** 3 including tutorials**Assessment:****ECTS credits:** 5

End-of-year Examination: This module will be examined jointly with MA4448 in a 3-hour examination in Trinity term, except that those taking just one of the two modules will have a 2 hour examination. However there will be separate results for MA3429 and MA4448.

Description:**Textbooks:**

Learning Outcomes: On successful completion of this module, students will be able to:

- Obtain a coordinate-induced basis for the tangent space and cotangent space at points of a differentiable manifold, construct a coordinate induced basis for arbitrary tensors and obtain the components of tensors in this basis.
- Determine whether a particular map is a tensor by either checking multi-linearity or by showing that the components transform according to the tensor transformation law.
- Construct manifestly chart-free definitions of the Lie derivative of a function and a vector, to compute these derivatives in a particular chart and hence compute the Lie derivative of an arbitrary tensor.
- Compute, explicitly, the covariant derivative of an arbitrary tensor.
- Define parallel transport, derive the geodesic equation and solve problems involving parallel transport of tensors.
- Obtain an expression for the Riemann curvature tensor in an arbitrary basis for a manifold with vanishing torsion, provide a geometric interpretation of what this tensor measures, derive various symmetries and results involving the curvature tensor.
- Define the metric, the Levi-Civita connection and the metric curvature tensor and compute the components of each of these tensors given a particular line-element.

- Re-derive the geodesic equation from an action principle and compute null, timelike, or spacelike geodesics on a particular space-time.
- Derive the Einstein equations or equations for similar metric theories from an action principle.

November 10, 2011