3305 (Mathematics for General Relativity)

Year:	2009–2010
Code:	MATH3305
Old Code:	MATHC348
Value:	Half unit (= 7.5 ECTS credits)
Term:	1
Structure:	3 hour lectures per week. Weekly assessed coursework.
Assessment:	90% examination, 10% coursework
Normal Pre-requisites:	6202 (Physicists and Astronomers), 7303 (Mathematicians)
Lecturer:	Dr M Dahl

Course Description and Objectives

The course introduces students to Einstein's theories of special and general relativity. Special relativity shows how measurements of physical quantities such as time and space can depend on an observer's frame of reference. Relativity also emphasizes that there exists an underlying physical description independent of observers. This physical description uses mathematical objects called vectors and tensors.

The Maxwell equations provide a description of electromagnetism compatible with special relativity. However, no similar equations exists for gravitation. Instead, a more general form of relativity is needed where spacetime has curvature. Objects no longer accelerate due to gravitational forces; instead they move along geodesics whose shape is determined by the curvature. Furthermore, rather than mass being the source of the gravitational field, a massive object warps the space around it, generating curvature.

Recommended Texts

J Foster & J D Nightingale, *A Short Course in General Relativity*, 1994.
S Weinberg, *Gravitation and Cosmology* (1972); R D'Inverno, *Introducing Einstein's Relativity* (1992).

Detailed Syllabus

1. Vectors and gradients.
2. Curved surfaces and spaces.
3. Metrics.
4. Tensor notation.
5. Electromagnetism in tensor notation.
6. The principle of equivalence.
7. Geodesics and the motion of objects in a curved space.
8. The deflection of starlight by the sun. The precession of Mercury.
9. Einstein field equations.