

## **Guide for the revision of Relativity (MTH6132)**

The final examination will be based on the following topics:

1. Lorentz transformations and its inverse. Invariants and invariance under Lorentz transformations. Spacetime  $(t,x)$  diagrams.
2. Basic relativistic effects: time dilation, length contraction, Doppler effect, causality.
3. Basic manipulations and definitions with 4-vectors. Norm and scalar product of 4-vectors.
4. Basic tensorial manipulations. Definitions of covariant, contravariant and mixed tensors of arbitrary rank (type). Tensoriality and basic proofs that certain objects are tensors.
5. Computation of the Christoffel symbols and curvature tensors for simple (2-dimensional) metrics —either by using the formula for the Christoffel symbols or by means of the Euler-Lagrange equations. Computation of components of the Riemann tensor.
6. The definition of line element. What does it mean that a metric is a solution to the vacuum Einstein field equations? The Minkowski metric as a solution to the Einstein equations.
7. The definitions of 4-velocity and 4-momentum. Basic manipulations with these objects. Collisions of massive particles and/or photons.
8. The notion of covariant derivative. Basic manipulations with covariant derivatives. The covariant derivative of the metric.
9. The Schwarzschild spacetime. The geodesic equations in the Schwarzschild spacetime. Simple problems involving the movement of massive particles and/or photons on the Schwarzschild spacetime.

***Revision lecture on the 24<sup>th</sup> April, 10:00, Eng. 2.16.***

### **Notes:**

The exam contains a list of all the formulae you will require in the exam. In particular, these include the Lorentz transformations, the formula for the covariant derivative, Christoffel symbols, the Riemann tensor, the Euler-Lagrange equations and the geodesic equations. You do not need to memorise these —what is important is that you know how to use them!

Good luck!

Dr. Juan A. Valiente Kroon

7<sup>th</sup> March, 2012.