

Questions for the General Relativity II exam, SS 2017

The candidate will draw randomly three questions from the list below, and will be asked to report on the topics drawn.

This list of questions gives a faithful representation of the contents of the lectures.

- i. Lie bracket, Jacobi identity, Levi-Civita connection, Riemann curvature tensor and its properties, the geodesic deviation equation
- ii. Inertial coordinates, Geodesic deviation (Jacobi equation), tidal forces
- iii. Einstein equations and matter: examples of energy-momentum tensors, dust in general relativity, the continuity equation
- iv. The Schwarzschild metric: the Eddington-Finkelstein extension; Time functions; the black hole; $r = 0$;
- v. The Schwarzschild metric: Stationary observers, the Flamm paraboloid
- vi. The Kruskal-Szekeres extension of the Schwarzschild metric
- vii. The Schwarzschild metric: Conformal Carter-Penrose diagram
- viii. The Schwarzschild metric: Geodesics, the interpretation of E , circular timelike geodesics, photons
- ix. The Schwarzschild metric: Circular null geodesics, gravitational redshift, weak field light bending
- x. Linearized Einstein equations, TT-gauge, linearized waves
- xi. Slowly varying weak gravitational fields, quadrupole formula, chirp mass
- xii. The Lie derivative, an axiomatic approach, relation to isometries
- xiii. Transporting tensor fields, flows of vector fields
- xiv. The Lie derivative: definition through flows
- xv. Isometries, Killing vectors, maximally symmetric space-times
- xvi. FRW metrics: Hubble law, cosmological red-shift formula, the red shift-factor z and distance
- xvii. The Friedman equation

$$\dot{R}^2 = \frac{\kappa K}{3R^2} + \frac{\kappa E}{3R} + \frac{1}{3}\Lambda R^2 - k,$$

its solutions, behavior for R small and large,