# Field Theory Exams

July 2010

—— EM ————-

* (`15 units`) Derive from Maxwell's equation the *continuity equation*:

$$\nabla \cdot \vec{J} + \frac{\partial \rho}{\partial t} = 0\,.$$

* (`25 units`) A transverse plane wave is incident normally in vacuum on a perfectly absorbing flat screen. (a) From the law of conservation of linear momentum, show that the pressure (called radiation pressure) exerted on the screen is equal to the field energy per unit volume in the wave.

* (`25 units`) For each of the Stokes parameters given below deduce the amplitude of the electric field up to an overall phase, in both linear polarization and circular polarization bases and make an accurate drawing showing the lengths and the arcs of one of the ellipses and its orientation.

  (a) $s_0 = -3$, $s_1 = -1$, $s_2 = 2$ and $s_3 = -2$

  (b) $s_0 = 25$, $s_1 = 0$, $s_2 = 24$ and $s_3 = 7$

—— GR ————-

* (`25 units`) For the metric:

$$ds^2 = dt^2 + (x^2 - t^2)dx^2$$

prove that
a) the only non-vanishing Christoffel symbols are :

$$\Gamma^x{}_{xx} = \frac{x}{x^2 - t^2}\,, \quad \Gamma^t{}_{xx} = t\,, \quad \Gamma^x{}_{tx} = \Gamma^x{}_{xt} = -\frac{t}{x^2 - t^2}$$

b) write the geodesic equations