General Relativity

Institute of Physics Bhubaneshwar

Homework 2

Textbook: Sean Carroll's Spacetime and Geometry Remember each homework carries weight. Late submissions will not be accepted.

Due on Monday 17/04/2017, 9.30 am

- 1. Read section 2.1 carefully, and discuss among yourselves various conceptual points. Unless you do this you will not gain much physical understanding of General Relativity. Write a short summary of the Gravitational Redshift phenomenon and argue why it suggests that spacetime is curved in General Relativity.
- 2. Read section 2.2, and think through various definitions and examples. Work through the stereographic coordinates of the S^2 and derive equations (2.9), (2.10), and (2.11).
- 3. Chapter 2, problem 4.
- 4. {Read section 2.7 for this problem.} Consider the following spacetime metric in 1+1 dimensions

$$ds^{2} = -\cos\lambda(dt^{2} - dx^{2}) - 2\sin\lambda \, dtdx \tag{0.1}$$

where

$$\lambda = \cot^{-1} t. \tag{0.2}$$

Find the equations of null rays and comment on the structure of light cones as t goes from $-\infty$ to $+\infty$. If you take x to be a periodic coordinate, are there closed timelike curves in the future? Are there such curves in the past?

- 5. Show that (for ω a *p*-form and η a *q*-form)
 - (a)

$$d(\omega \wedge \eta) = d\omega \wedge \eta + (-1)^p \omega \wedge d\eta, \qquad (0.3)$$

(b)

$$d^2\omega = 0. \tag{0.4}$$