General Relativity

Institute of Physics Bhubaneshwar

Homework 1

Textbook: Sean Carroll's *Spacetime and Geometry*

Remember each homework carries weight.

Late submissions will not be accepted.

1. Work through section 1.8 of Sean Carroll's textbook and express Maxwell's equations (1.92) in tensorial form (1.95) and (1.97). Show your calculations.

2. Show that the curve

$$
\begin{aligned}
x(\lambda) &= \int_0^\lambda r \cos\theta \cos\phi \; d\xi, && (0.1)\\
y(\lambda) &= \int_0^\lambda r \cos\theta \sin\phi \; d\xi, && (0.2)\\
z(\lambda) &= \int_0^\lambda r \sin\theta \; d\xi, && (0.3)\\
t(\lambda) &= \int_0^\lambda r \; d\xi, && (0.4)
\end{aligned}
$$

   where r, θ, and ϕ are arbitrary functions of the parameter ξ is a null curve in special relativity.

3. Analyse the conservation equations for the stress tensor for a perfect fluid following discussion on p 36-37 of the textbook. Exhibit how the continuity equation and the Euler equation are recovered.

4. Read section 1.10 carefully. Starting with the Lagrangian (1.162) arrive at the equations of motion (1.169).

5. Using appropriate equations of motion show that the Energy-Momentum stress-tensors (1.170) and (1.171) are conserved.