

University of Minnesota
School of Physics and Astronomy

2025 Fall Physics 8501

General Relativity I

Assignment Solution

Lecture Instructor: Professor Joseph Kapusta

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Assignment 3 due on Monday September 22th at 5PM

Question 1

Show explicitly that the 4-vector current density for a collection of point charges satisfies $\partial_\mu J^\mu = 0$

Question 2

Prove that the electromagnetic energy density squared minus the square of the Poynting vector is a Lorentz invariant for an electromagnetic field by expressing this quantity in terms of tensors. You might consider using the dual field strength tensor defined by $\tilde{F}^{\mu\nu} = \frac{1}{2}\varepsilon^{\mu\nu\alpha\beta}F_{\alpha\beta}$.

Question 3

Calculate the scalar T^α_α associated with the electromagnetic stress tensor.