Physics 139
Spring 2014
Homework 11
Due Friday, April 18, 2014

Reading Assignment: Please read Hartle, pp. 426–434. My approach in lecture to the connection coefficients $\Gamma^{\mu}_{\alpha\beta}$ was different than Hartle's. At the bottom of p. 432 he states, "However, the resulting formula is not much use except to show that the $\tilde{\Gamma}^{\alpha}_{\beta\gamma}$ are symmetric in β and γ (Problem 10)." His argument has two steps. First, he uses the formula in question (which he assigns to Problem 10) to show that the connection coefficients are symmetric in the lower two indices. Next, by requiring that a geodesic be given by $\nabla_{\mathbf{u}}\mathbf{u} = 0$, he argues that $\tilde{\Gamma}$ must be the same as Γ. But in lecture I derived Hartle's "resulting formula" (therby doing Problem 10 for you), and showed that it implies not only that $\tilde{\Gamma}$ is symmetric in the lower two indices, but in addition that $\tilde{\Gamma} = \Gamma$. (In lecture I wrote A instead of $\tilde{\Gamma}$). When I return on Tuesday I will try to post some notes on this topic.

There are only four easy problems this week, but try to make sure you understand vectors, dual vectors, tensors, upper and lower indices, parallel transport and covariant derivatives. This is all important for what will follow.

1. Problem 20.3, p. 441.

2. Problem 20.4, p. 442.

3. Problem 20.5, p. 442.

4. Problem 20.9, p. 442.