

Topic 5 – Derivatives, Velocities, Energy and Momentum Special Relativity

Pre-Lecture Reading/Post-Lecture Summary

We will continue our exploration of special relativity based on the $SO(1,3)$ set of Lorentz transformations. I will begin by reminding you of the important and unique roles of the metric and transformation operators, particularly in terms of how they work with index notation. I will provide a simple example of switching between matrix and index manipulations in order to highlight subtleties therein. We will then begin an exploration of how to generalize the two types of derivatives we normally work with in 3D to special relativity, these being the gradient operator and time derivative. You might think that we will simply combine them to make a 4-derivative, but actually it is a bit more complicated than that. We will actually develop two very different and separately useful derivatives that we will often use, one for particles and one for fields. This will then allow us to generalize the notion of velocity to 4-velocities which will in turn allow us to define a 4-momentum. With this definition we will be able to unearth many of the interesting kinematic results of special relativity. Then you will leave and be happy.