General Relativity - PHY 6938

HW 3

Hand in this homework.

READ: Chap 2.2-2.10

PROBLEMS:

1. The collision of particles A and B (in Minkowski) with 4-momenta $p^\alpha_{(A)} = (3, -1, 0, 0)$ and $p^\alpha_{(B)} = (2, 1, 1, 0)$ results in the destruction of A and B and the production of 3 new particles C, D, and E. Particles C and D have momenta $p^\alpha_{(C)} = (1, 1, 0, 0)$ and $p^\alpha_{(D)} = (1, -1/2, 0, 0)$.
(a) Find the rest mass of particle E.
(b) Find the 3-velocity of the center of mass frame.

2. Consider the timelike unit 4-vector U, and the tensor $P = g + U \otimes U$, where g is the metric tensor.
Show that P is a projection operator that projects an arbitrary vector V into one orthogonal to U. That is, show that the vector $V_\perp$ whose components are

$$V^\alpha_\perp = P^\alpha_\beta V^\beta$$

is
(a) orthogonal to U and
(b) unaffected by P.
(c) Show that P is the metric tensor for vectors orthogonal to U. I.e. show

$$P(V_\perp, W_\perp) = g(V_\perp, W_\perp) = g_{\alpha\beta} V^\alpha_\perp W^\beta_\perp.$$

(d) Write down the same projector P if U is an arbitrary nonnull vector.

3. Do the following problems from Carroll's book: 2.4, 2.5, 2.6, 2.8