Assignment Six (aka Take-Home Final), Due Tuesday, June 13, noon.

[1.] Two Frames S and S’ have axes which are parallel and origins which coincide at \( t = t' = 0 \). If S’ moves with velocity \( \vec{v} = v (\cos \phi \hat{x} + \sin \phi \hat{y}) \) with respect to S, write down the Lorentz transformation matrix \( \Lambda \).

[2.] Find the magnetic field of a point charge \( q \) moving with velocity \( \vec{v} \) and show that it reduces to the Biot-Savart result in the limit \( v/c \ll 1 \).

[3.] Show that

\[
(F^\mu \nu)' = \Lambda^\mu_\rho \Lambda^\nu_\sigma (F^{\rho \sigma})
\]

gives the correct rules for the transformation of the electric and magnetic fields.

[4.] Show that

\[
\frac{F^{\mu \nu}}{\partial x^\nu} = \mu_0 J^\mu \quad \frac{G^{\mu \nu}}{\partial x^\nu} = 0
\]

are an alternative re-writing of the Maxwell equations.

[5.] Express

\[
F^{\mu \nu} F^\mu_\nu
\]

in terms of the electric and magnetic fields.