Electrodynamics A (PHY 5346) Fall 2016 Midterm October 11.

1. **Spacetrip (40%).**

   (A) Assume that the earth is in an inertial frame. A spaceship leaves the earth at time 0. The spaceship is constructed so that it has an acceleration g in each of its own instantaneous rest frames. By its own clock, it accelerates on a straight-line path for 1 year, decelerates at the same rate for 1 year, turns around, accelerates for 1 year, decelerates for 1 year, and lands on earth. Calculate the time on earth at the landing.

   Instructions: Use $g = 9.81\ [m/s^2]$, one year $= 365 \times 24 \times 3600\ [s]$ and for the speed of light $c = 300,000\ [km/s]$. State the result in units of years and decimal fractions of years to at least three significant digits. Hint: Find first $\zeta(\tau)$, where τ is the proper time in the spaceship and $\zeta(\tau)$ its rapidity with respect to Earth.

   (B) How far away from Earth did the spaceship travel? Express the result in light years.

2. **Lorentz invariance of antisymmetry (20%).**

   Show that an antisymmetric tensor $F^{\alpha\beta}$ stays antisymmetric under Lorentz transformations, i.e.,

   $$F'^{\alpha\beta} = -F'^{\beta\alpha} \quad \text{with} \quad F'^{\alpha\beta} = a^{\alpha}{}_{\hat{\alpha}}\, a^{\beta}{}_{\hat{\beta}}\, F^{\hat{\alpha}\hat{\beta}} \ .$$

3. **Some electromagnetic invariants (40%).**

   Express the invariants $F_{\alpha\beta}\, F^{\alpha\beta}$, $F_{\alpha\beta}\, {}^*F^{\alpha\beta}$ and ${}^*F_{\alpha\beta}\, {}^*F^{\alpha\beta}$ in terms of $\vec{E}$ and $\vec{B}$ fields, where ${}^*F^{\alpha\beta}$ is the dual tensor.