1. Let \( Z = Z_x dx + Z_y dy + Z_z dz + Z_t dt \) be a 1-form, where the components depend on all of the usual Cartesian coordinates in spacetime, i.e., \( \{x, y, z, t\} \). Create the Hodge dual \( *Z \), which then lives in the vector space \( \Lambda^3 \). Then calculate the exterior derivative of this 3-form, which is then a 4-form. Lastly, calculate its Hodge dual, which is simply a scalar function.

2. \( T^\mu_\lambda \) are the components of a tensor of type [1,1], as, perhaps, can be seen from the location of the indices, and is currently presented, as such a tensor, relative to the basis of that vector space, as
\[
T = T^\mu_\lambda \, dx^\lambda \otimes \frac{\partial}{\partial x^\mu}.
\]
Please use the metric tensor, \( \eta_{\mu\nu} \) and/or its inverse to find matrix presentations of \( T^{\alpha\beta} \) and \( T_{\rho\sigma} \).

3. Begin with the usual form of the Faraday, as a 2-form over spacetime, in special relativity, namely \( F_{\mu\nu} \, dx^\mu \wedge dx^\nu \). Determine the Lorentz invariant quantity \( F_{\mu\nu} F^{\mu\nu} \). Then show that if we use the skew-symmetric matrix \( F \) to present the components of the original 2-form, that
a. the quantities \( F^{\mu\nu} \) are presented via the matrix \( W \equiv H^T F H \). Lastly, find the relation between our invariant and the trace of the matrix product of \( F \) and \( W \).

4. Work out the 3-dimensional plus 1-dimensional forms of the proper-time derivative of the 4-momentum, which should involve the 3-dimensional force and power, perhaps?