Phenomenology course: Problem Sheet 3

1. On proving gauge invariance (referred to several times in the lectures): show that in the so-called Landau gauge,

$$\sum_\lambda \epsilon^\mu(k,\lambda)\epsilon^{\nu *}(k,\lambda) = -g^{\mu\nu} + \frac{k^\mu k^\nu}{k^2 + i\varepsilon},$$

   the term $\propto k^\mu k^\nu$ added to the photon spin sum $-g^{\mu\nu}$ of the Feynman gauge does not contribute to QED Compton scattering $e^-\gamma \to e^-\gamma$. Neglect the electron mass.

(*Hint:* To prove gauge invariance is sufficient to replace, e.g., $\epsilon^\mu(k,\lambda) \to k^\mu$ in the expressions you derived (i.e., prior to any squaring, tracing, etc.) and show, after some manipulations, that the *sum* of the two amplitudes is zero. Do it for just one photon.)