c) (2 points) Suppose now that an electromagnetic wave of angular frequency ω impinges on the surface of this material, where $1/\tau \ll \omega < \omega_\mathrm{p}$. Show that the the part of the electric field that penetrates the material falls off as $\exp(-z/d)$. Calculate d as a function of ω. Neglect any correction of order $1/\omega\tau$ or smaller. [Hint: do not waste time matching boundary conditions at the surface. That's not what this is about. Focus on the form of the field inside the material].

This part is a continuation of part c). Suppose that the electric field penetrating the sample is in the x direction and varies as

$$E_x(z,t) = E_x^0 \exp(-z/d) \cos \omega t.$$

d) (2 points) Use Eq. (1) to calculate the corresponding current density $j(z,t)$. Show that there is no net dissipation or power absorption by the metal. Explain in words how it can be that the signal is decreasing with distance without power absorption; what is happening?

e) (2 points) Suppose now that the impinging electromagnetic wave has a very small frequency $\omega \ll 1/\tau \ll \omega_\mathrm{p}$. Show now that the wave penetrates a much greater distance, and that the envelope of the transmitted wave decays as $\exp(-z/\delta)$. Calculate δ. What is the origin of the damping in this case?