1. Jackson 8.2, parts (a),(b),(c)
A transmission line consisting of two concentric circular cylinders of metal with conductivity $\sigma$ and skin depth $\delta$ is filled with a uniform lossless dielectric $(\mu, \varepsilon)$. A TEM mode is propagated along this line.

(a) Show that the time-averaged power flow along the line is

$$ P = \frac{\mu}{\varepsilon} \pi a^2 |H_0|^2 \ln \left( \frac{b}{a} \right) $$

where $H_0$ is the peak value of the azimuthal magnetic field at the surface of the inner conductor.

(b) Show that the transmitted power is attenuated along the line as

$$ P(z) = P_0 e^{-2\gamma z} $$

where

$$ \gamma = \frac{1}{2\sigma \delta} \sqrt{\frac{\mu}{\varepsilon}} \ln \left( \frac{b}{a} \right) $$

(c) The characteristic impedance $Z_0$ of the line is defined as the ratio of the voltage between the cylinders to the axial current flowing in one of them at any position $z$. Show that for this line

$$ Z_0 = \frac{1}{2\pi} \sqrt{\frac{\mu}{\varepsilon}} \ln \left( \frac{b}{a} \right) $$