**10.18** A manufacturer produces a ferrite material with $\mu = 750\mu_o$, $\varepsilon = 5\varepsilon_o$, and $\sigma = 10^{-6}$ S/m at 10 MHz.

(a) Would you classify the material as lossless, lowloss, lossy, or conducting?

(b) Calculate $\beta$ and $\lambda$.

(c) Determine the phase difference between two points separated by 2 m.

(d) Find the intrinsic impedance.

- For part a), add choice of 'low loss'. Also, find (e) skin depth and (f) loss tangent.

a) Compute loss tangent per (10.37)

f) $\tan\theta = \frac{\sigma}{\omega\epsilon} = \frac{1\times10^{-6}}{2\pi(10\times10^6)(5)8.8541878\times10^{-12}} =$

$\tan\theta = \frac{\sigma}{\omega\epsilon} = 0.0003595 \ll 1$

$\Rightarrow$ very lowloss material

b) Per (10.43a), $\beta = \omega\sqrt{\mu\epsilon} = 2\pi(10\times10^6)\sqrt{750(4\pi\times10^{-7})5(8.854\times10^{-12})}$

$\beta = 12.8344 \frac{rad}{m}$

(10.43b) $\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{12.8344} = 0.48956\ m$

c) phase difference $= \beta d = 12.8344(2)$

$\beta d = 25.669\ rad = 1470.7^\circ$

d) Be exact (10.32) $\eta = \sqrt{\frac{j\omega\mu}{\sigma+j\omega\epsilon}}$

$\eta = \sqrt{\frac{j2\pi10^7(750)4\pi\times10^{-7}}{10^{-6}+j2\pi10^7(5)(8.854\times10^{-12})}} = 4613.985\angle 0.01^\circ\ \Omega$

e) $\gamma = \sqrt{j\omega\mu(\sigma+j\omega\epsilon)} = \sqrt{j2\pi10^7(750)4\pi\times10^{-7}[10^{-6}+j2\pi10^7(5)8.854\times10^{-12}]}$

$= 0.002306993 + j12.83438\ m^{-1}$

Per (10.54a) $\delta = \frac{1}{\alpha} = \frac{1}{0.002307} = 433.465\ m$